Step Servo Quick Tuner Software Manual

1 Revision History

Version	Author	Participator	Date	Changes
1.0	Austin		2013-7-19	Initial release
1.1	Jay	Frank, Jimmy	2014-12-31	Update new features in Step Servo Quick Tuner 3.0
1.2	JK, MC		2015-1-21	Improved grammar and punctuation

2 Contents

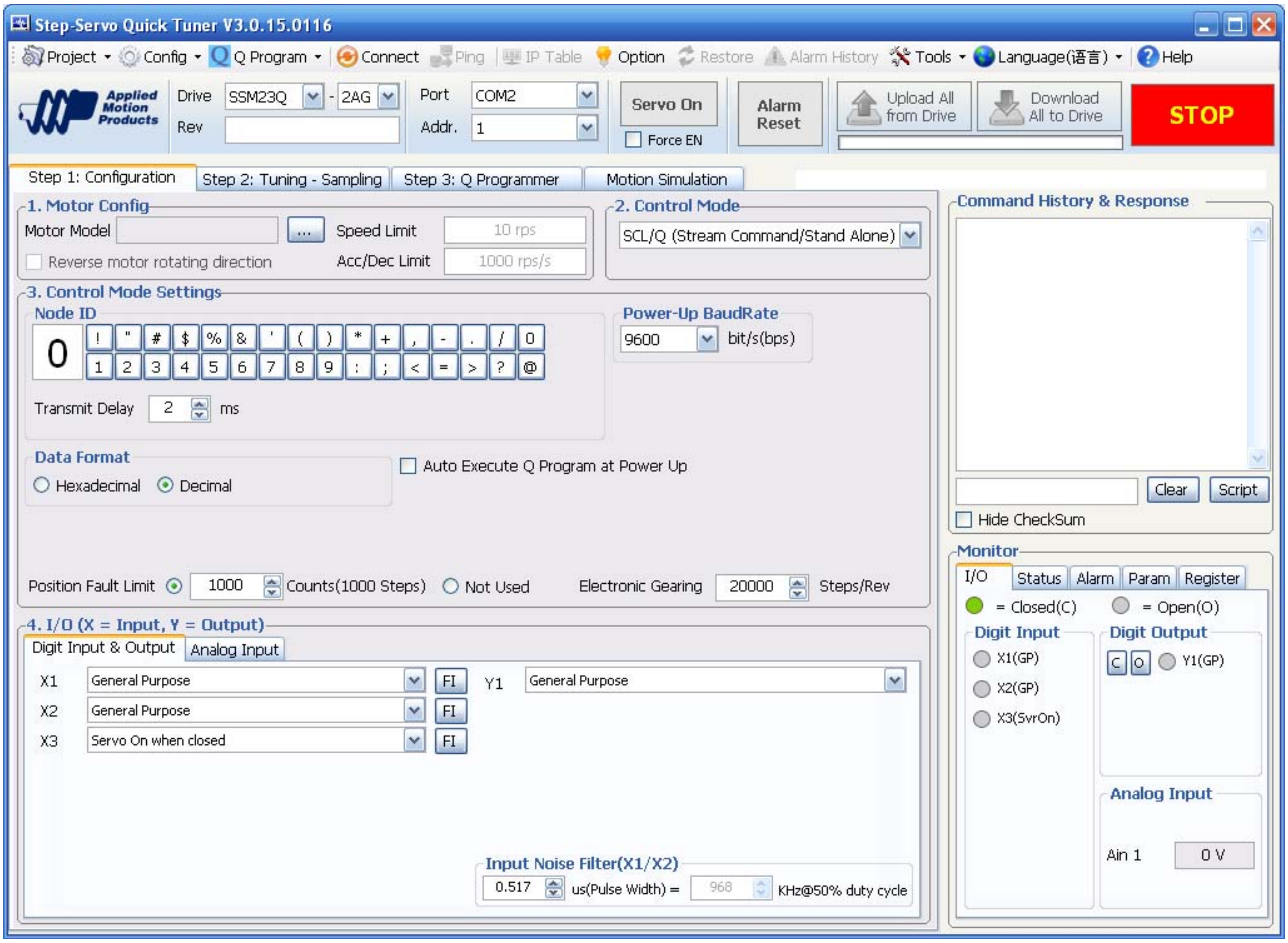
3 Introduction

Thank you for purchasing an Applied Motion Products Step Servo product. The Step Servo is an innovative revolution for the world of step motors; it enhances step motors with servo technology to create a product with exceptional feature and broad capability. Applied Motion Products' Step Servo family includes the SSM, TSM and TXM integrated drive+motor, plus SS and SSAC series stand alone Step Servo drives.

- TSM series integrated Step Servo motors
- SSM series integrated Step Servo motors with Ethernet
- TXM series IP65-rated integrated Step Servo motors for harsh environments
- SS series Step Servo drives
- SSAC series Step Servo AC drives

3.1 Step Servo Quick Tuner Overview

Step Servo Quick Tuner is a Windows based software application to configure, perform servo tuning, program the Q programming, drive testing and evaluation of the Step Servo product. This help explains how to install *Step Servo Quick Tuner* and how to configure and tune your Step Servo system. For information regarding your specific hardware, such as wiring and mounting, please read the hardware manual that came with the product.



The features of *Step Servo Quick Tuner* include:

- Friendly Interface
- Easy setup within just three steps
- Drive setup and configuration
- Servo tuning and sampling
- Built-in Q programmer
- Motion testing and monitoring
- Write and save SCL command scripts
- Online help integrated
- Support for all Step Servo products in TSM/SSM/TXM/SS/SSAC series

Remember, if you get in trouble with our motor, drive or software, or if you have any suggestions about our products and this manual, please call Applied Motion Products Customer Support: (800) 525-1609, or visit us online at www.applied-motion.com.

Software Environment:

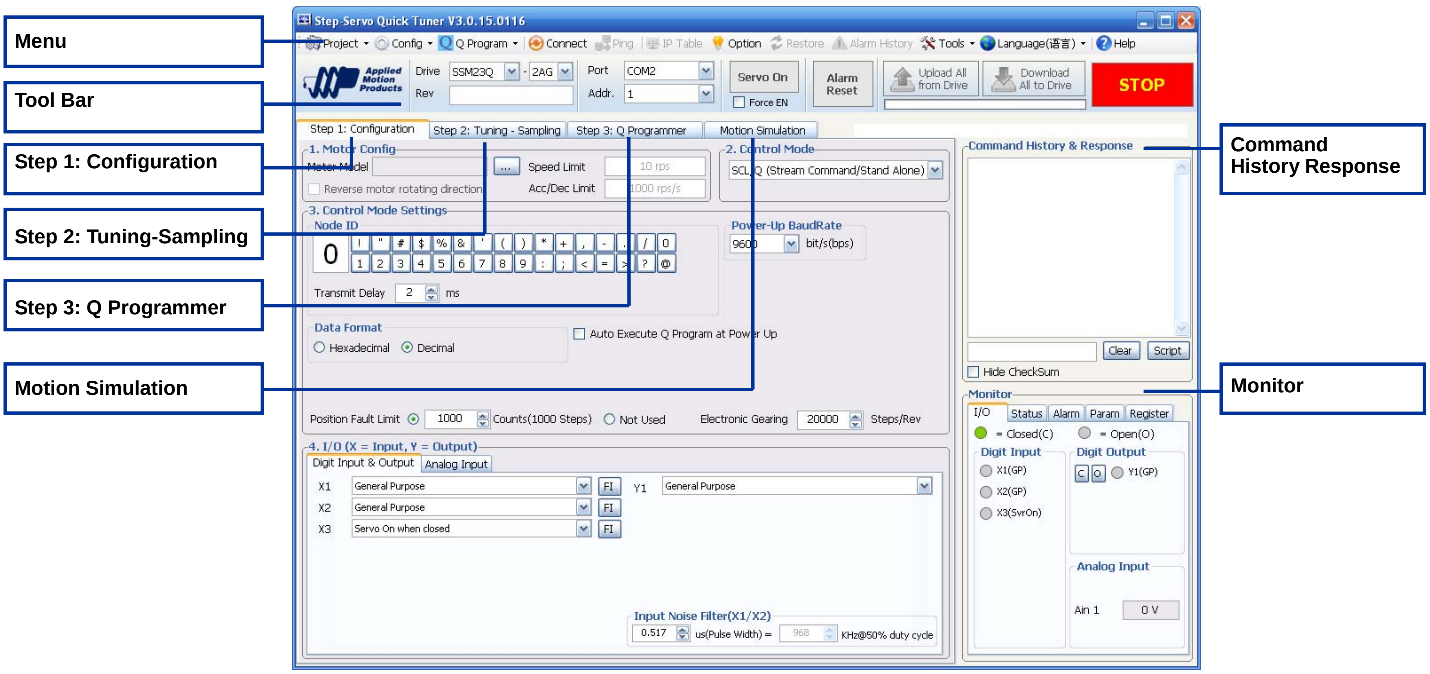
Microsoft XP (Service Pack 3), Windows 7/8,Vista with 32bit or 64 bit

Microsoft .Net Framework 2.0

3.2 User Interface

To launch ***Step Servo Quick Tuner 3*** on your Windows PC, click ***Start*** → ***Programs*** → ***Applied Motion Products*** → ***Step Servo Quick Tuner 3*** → ***Step Servo Quick Tuner 3***.

The main screen includes these sections: Menu, Tool Bar, Step 1: Configuration, Step 2: Tuning-Sampling, Step 3: Q Programmer (Only for –Q/-C Type) and Motion Simulation. See picture below.



Menu

The main menu provides some frequently-used operations for configuration and drive control.

Tool Bar

The tool bar is used to set the communication, drive model, Servo status control, Alarm Reset, Upload & Download.

Step 1: Configuration

This tab provides the drive configuration settings.

Step 2: Tuning-Sampling

This tab provides the tuning and sampling settings, start sample and display sampling curve diagram.

Step 3: Q Programmer

This tab provides the necessary functionality to develop and test Q programs, which are stored in the drive and can operate stand alone or with the interaction of a host device like a PC, PLC or HMI. It is only for –Q and –C type.

Motion Simulation

This tab provides motion testing, such as point to point motion, jogging and homing.

SCL Terminal

The SCL Terminal allows you to send SCL commands to the drive. It's a good way to learn how to use SCL commands before writing a custom software program to send SCL streaming commands the drive. The SCL Terminal can also be useful for diagnostics and debugging. For more information about SCL commands, please refer to the Host Command Reference, available at
http://www.applied-motion.com/products/software/scl-utility

Status Monitor

The Status Monitor can display I/O status, Drive status, Alarms, Parameters and Registers.

4 Connecting your Drive to *Step Servo Quick Tuner*

Step Servo Quick Tuner supports two connection types, serial port and Ethernet. For serial port drives, the connection includes following steps

- Connect the drive to your PC COM port
- Launch *Step Servo Quick Tuner*
- Switch to RS-232 and select the COM port, see picture below
- Power up the drive
- *Step Servo Quick Tuner* will recognize the drive model and revision

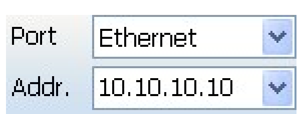
When launching *Step Servo Quick Tuner*, the software will search all COM ports available and load then into the drop down list.

After establishing the connection between the drive and *Step Servo Quick Tuner*, the software will switch the baud rate to 115200 bps, no matter what the baud rate was before.

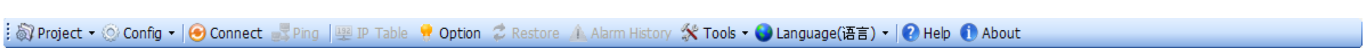
For Ethernet drives, the connection includes following steps

- Connect the drive and PC to your switch or router
- Launch *Step Servo Quick Tuner*
- Switch to Ethernet and input the drive's IP address, as pictured below
- Power up the drive

Step Servo Quick Tuner will not detect the drive information automatically, you need to click "Upload" button in the main screen to get the drive model and revision.



4.1 Menu

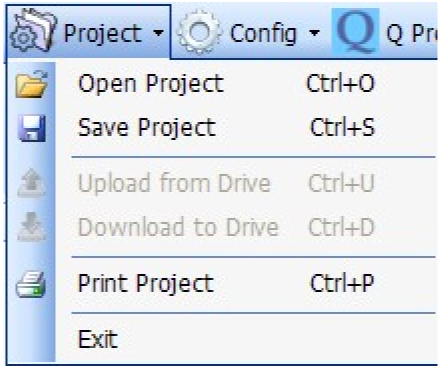


1st Stage Menu	2nd Stage Menu	Hot Key	Function
Project	Open	Ctrl+O	Open the project file (.ssprj format)
	Save	Ctrl+S	Save the project file (.ssprj format)
	Upload from Drive	Ctrl+U	Upload the project from the drive
	Download to Drive	Ctrl+D	Download the project to the drive
	Print	Ctrl+P	Print the current project
	Exit		Exit *Step Servo Quick Tuner*
Config	Open Config	Ctrl+Shift+O	Open configuration file (.ssc format)
	Save Config	Ctrl+Shift+S	Save configuration file (.ssc format)
	Upload from Drive	Ctrl+Shift+U	Upload configuration from the drive
	Download to Drive	Ctrl+Shift+D	Download configuration to the drive
	Print	Ctrl+Shift+P	Print current configuration
Q Program	Open Q Program		Open Q program file (.qpr format)
	Save Q Program		Save Q program file (.qpr format)
	Open Segment		Open Q segment file (.qsg format)
	Save Segment		Save Q segment file (.qsg format)
	Upload from Drive		Upload Q program from the drive
	Download to Drive		Download Q program to the drive
	Clear Q Program		Clear Q program
	Set Password		Set password to secure Q program
	Print Q Program		Print Q program
Connect			Connect or re-connect to the drive
Ping			Ping the Ethernet drive
IP Table			Edit the drive's table of switch selectable IP addresses
Option			Set Alarm, Regen, Communication and other options
Restore			Restore the drive to the factory default settings
Alarm History			Display drive's alarm history
Tools	Firmware Downloader		Upgrade the drive's firmware
	Move Profile Calculator		Pilot motion profile based on target distance, velocity, acceleration/deceleration, etc.
	Export CANopen Parameters		Export CANopen Parameters to a file
	CANopen Test Tool		Run CANopen Test Tool application (requires pre-installation)
Language	English		Set the application language to English
	Chinese		Set the application language to Chinese
Help			Open the online help

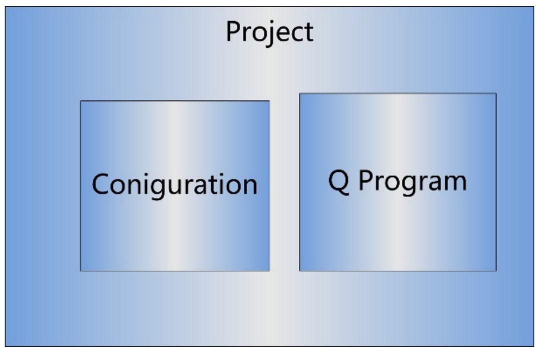
4.1.1. Project

In Project menu, *Step Servo Quick Tuner* can allow you to upload and download both configurations and a Q program. Driver configuration and Q programs can be saved as a project file (.ssprj) to your local disk. It

can also download the project files to a different drive directly from the hard disk. In addition, it can also print out the detailed project files.



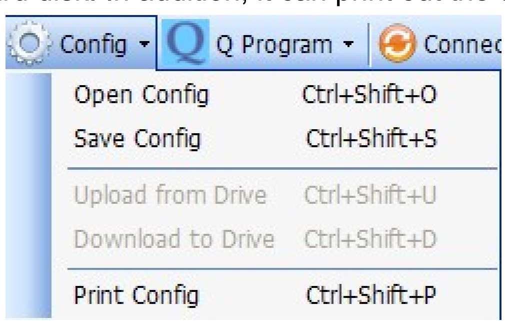
For drives that support Q programming capability, the project includes the configuration and Q program; see below:



For drives without Q programming, the project is the same as the configuration.

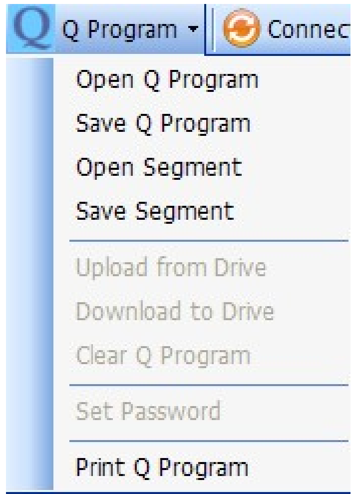
4.1.2. Configuration

In Config menu, *Step Servo Quick Tuner* allows you to upload and download configurations to and from the drive. It can also save as configuration file (.sscfg) to your local disk and download configurations to a different drive directly from the hard disk. In addition, it can print out the detailed configuration files.



4.1.3. Q program

If your drive is a Q, C or IP type, the Q Program menu can save driver's Q program file (.qpr) to your local disk. It can also download a Q program to a different drive directly from the hard disk. In addition, it can print out your Q program.



4.1.4. Connect

Connect *Step Servo Quick Tuner* to the drive.

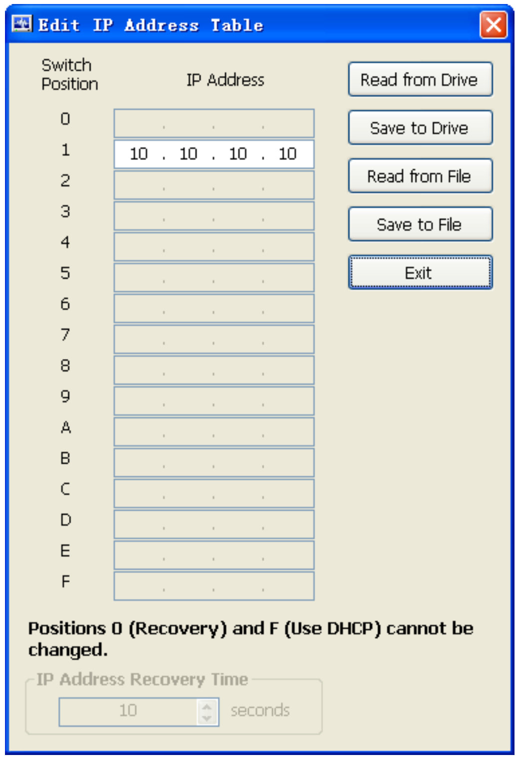
4.1.5. Ping

Ping will verify your network configuration and ensure that the software can communicate with the drive. Click “Ping” button, the software will check drive's ARM build number and MAC ID.

4.1.6. IP Table

IP Table is used to edit the table of switch selectable IP addresses stored in drives with Ethernet ports. You can input up to 14 IP addresses for the rotary switch positions 1 through E.

Note: After saving the IP address table to the drive, you must power cycle the drive before a new address can take effect.



For TXM Ethernet drives, which have no IP address selection switch, there is only one IP address setting available, shown as 10.10.10.10 in the image above. You can set this to any valid IP address that suits the requirements of your network and application. Should you ever forget this address, you will need a way to recover the drive. All TXM drives include a permanently fixed recovery address of 10.10.10.10. The TXM will use this recovery address if it powers up and does not detect a network connection for some period of time. You can set this time delay period in the IP Address Table dialog.

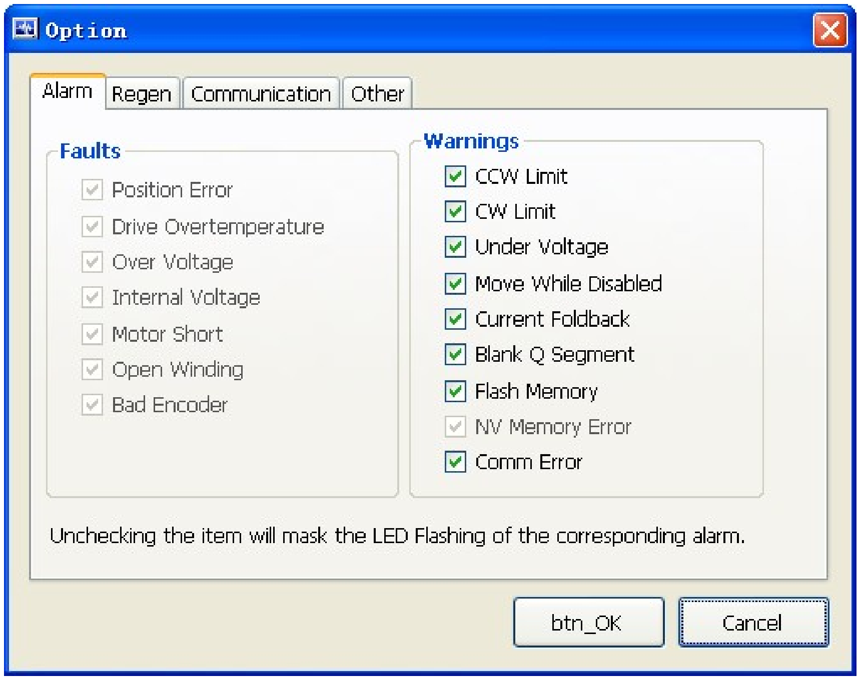
Example: if you set the time delay for 5 seconds, you can force the drive to revert to the recovery address by powering it up with the Ethernet cable unplugged, then waiting for five seconds before plugging in the cable.

4.1.7. Option

Allows you to set the alarm mask, regeneration resistor, and other parameters

4.1.7.1 Alarm Menu

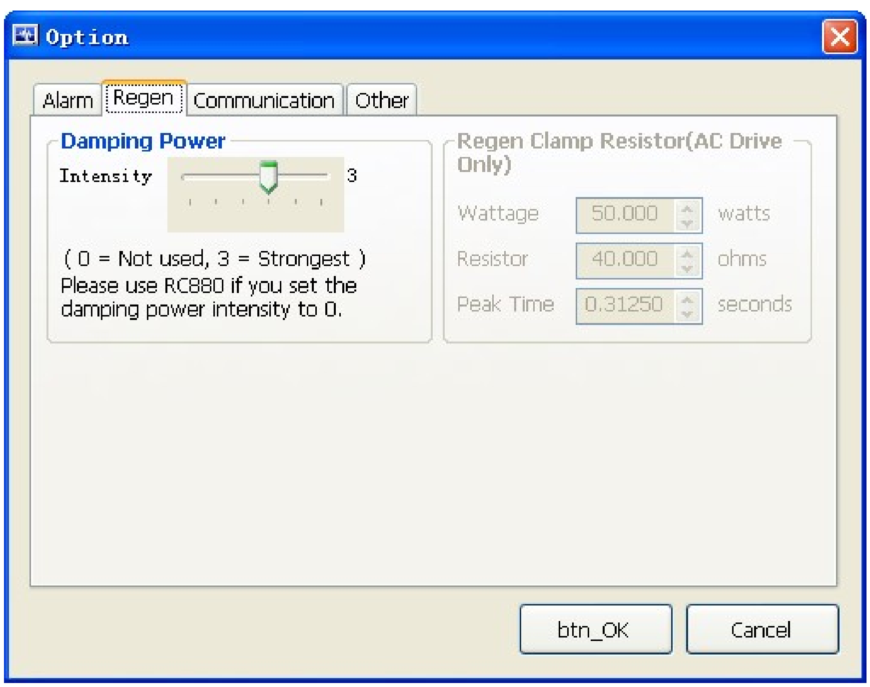
Sometimes you may see LED alarm codes displayed on your drive that you don't want to see because they are part of the normal operation of your application, such as tripping an end of travel limit. In this case you can inhibit these alarms. Clicking the "LED Flashing" button in the menu will present the following dialog.



Uncheck the alarms you want to inhibit; if your drive encounters such alarms, it will not display the alarms by LED. However, the drive will record them and store them in the alarm history for future examination.

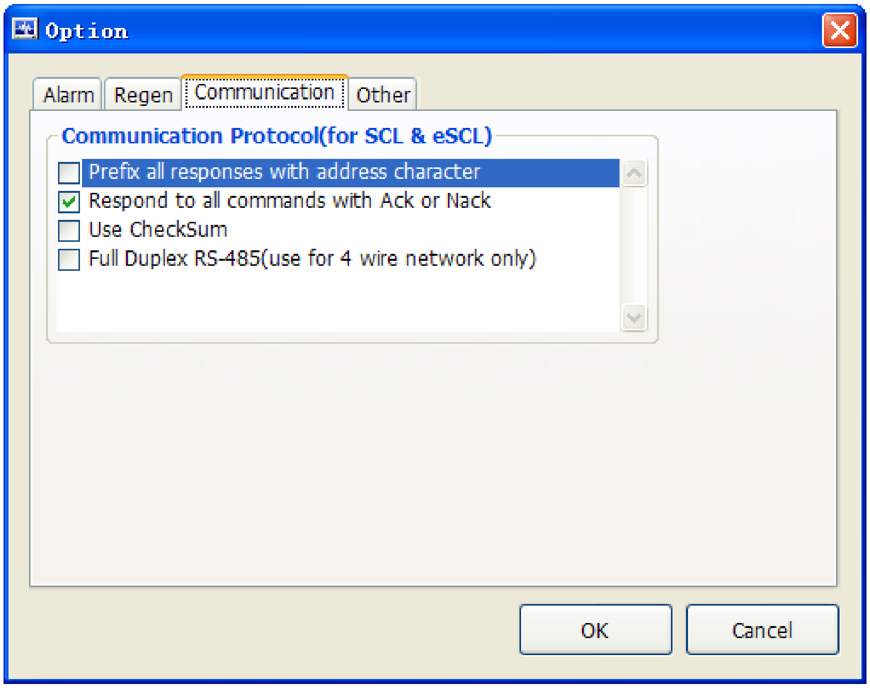
4.1.7.2 Regeneration Resistor

SS drives contain an internal regeneration resistor to safely capture kinetic energy returning to the drive from a rapidly decelerating load so that it does not damage the drive or power supply. This page will help you set it up.



4.1.7.3 Communication

This page is for setting the communication preferences between the host controller and step servo drive.



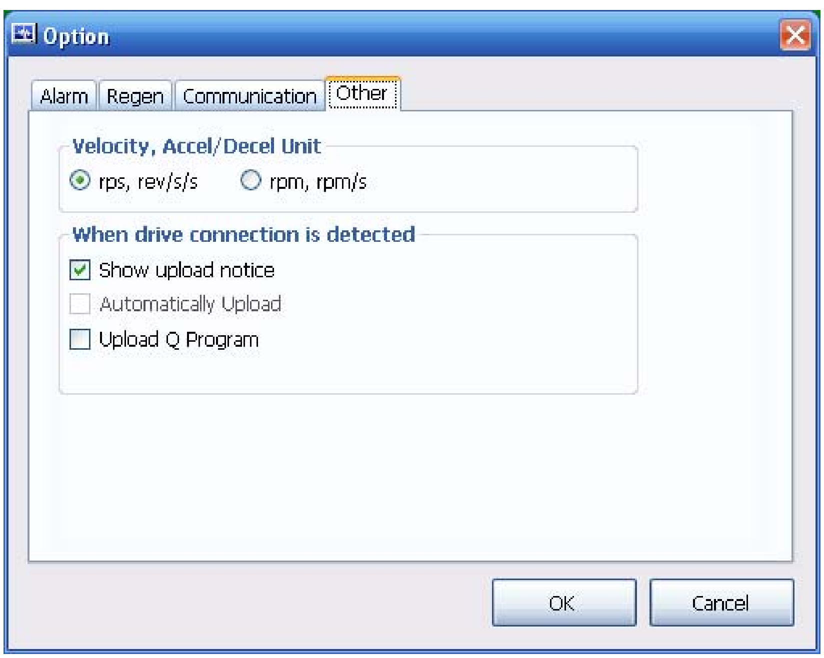
Prefix all responses with address character: Instructs the driver to respond to SCL commands with an address character prefix.

Respond to all commands with Ack or Nack: Respond to all commands with Ack or Nak

Use CheckSum: Use CheckSum during communication

Full Duplex RS-485: Select this for full duplex, 4 wire RS-422/485 networks

4.1.7.4 Other



Velocity, Accel/Decel Unit: Unit settings for velocity, acceleration and deceleration: you can choose revolutions per second (rps) and rev/sec/sec (rev/s/s) or revolutions per minute (rpm) and rpm/s/s.

When drive is connected: You can choose whether to automatically upload the configuration and/or Q program from the drive when a drive is first connected to *Step Servo Quick Tuner*.

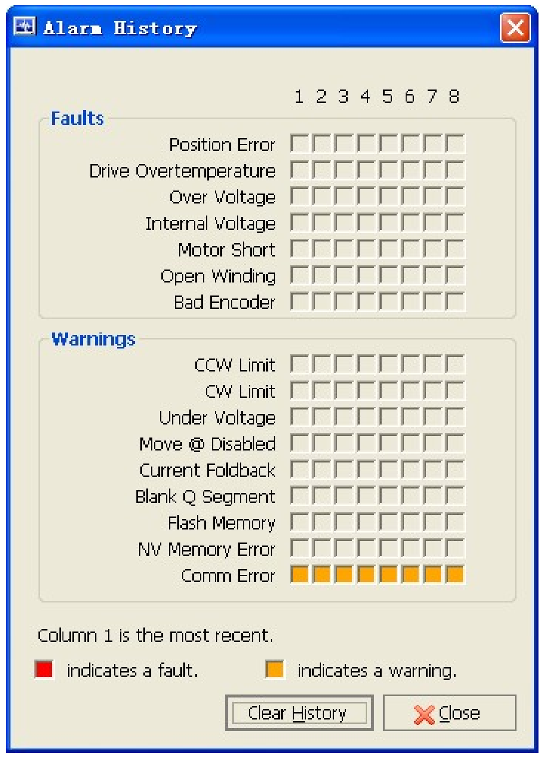
4.1.8. Restore Factory Default

The restore button will reset all the parameters on the drive to the default factory settings.

Note: This will erase all the parameters you have changed, so you may need to save them to a file first.

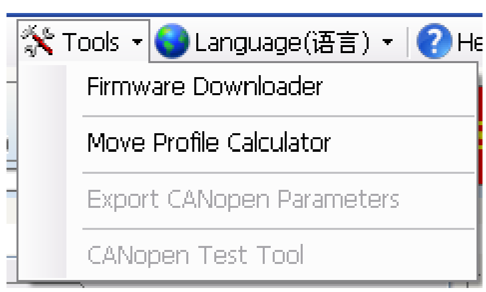
4.1.9. Alarm History

Applied Motion Products Step Servo drives store a log of previous alarm conditions. Each time there is an alarm, the drive stores the information of which alarms were triggered at this time. Since a fault may trigger more than one alarm condition, the drive stores all of them for reference. This information can then be extracted using *Step Servo Quick Tuner* to help with drive and system problem solving. The drive stores up to 8 sets alarm conditions.



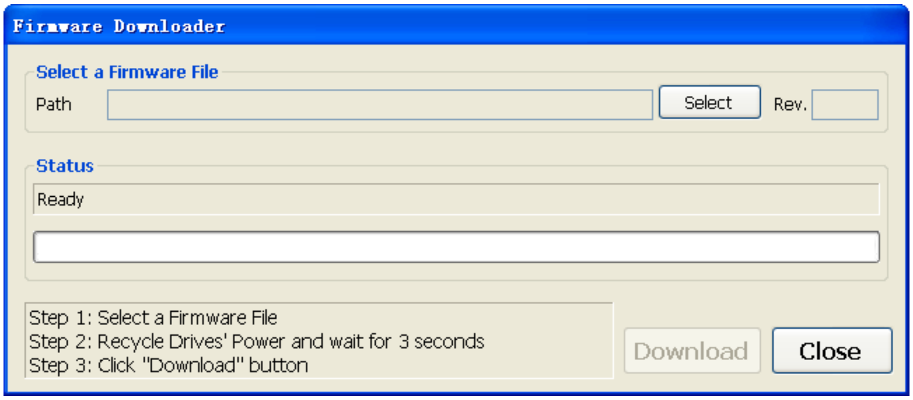
4.1.10. Tools

The Tools menu includes Firmware Downloader, Motion Profile Calculator, Export CANopen Parameters and CANopen Test Tool, see picture below:



4.1.10.1 Firmware Downloader

Firmware Downloader is used to upgrade the drive firmware. Before upgrading please contact Applied Motion Products to confirm that you get the proper firmware version to download.



Please follow this sequence to perform a firmware update:

Step 1: Select a firmware file

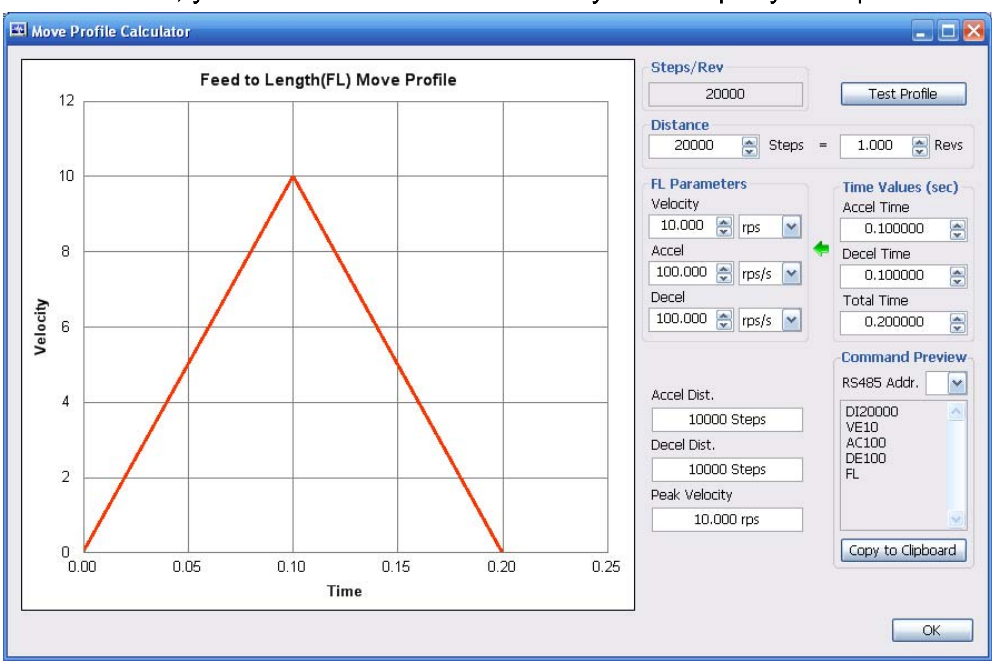
Step 2: Recycle the drive's power and wait for 3 seconds

Step 3: Click the "Download" button.

Note: So far Applied Motion Products' drives do not support multi axis networking firmware updates for RS-485 field bus. You can only do the firmware updates for each single axis which must be offline from the network.

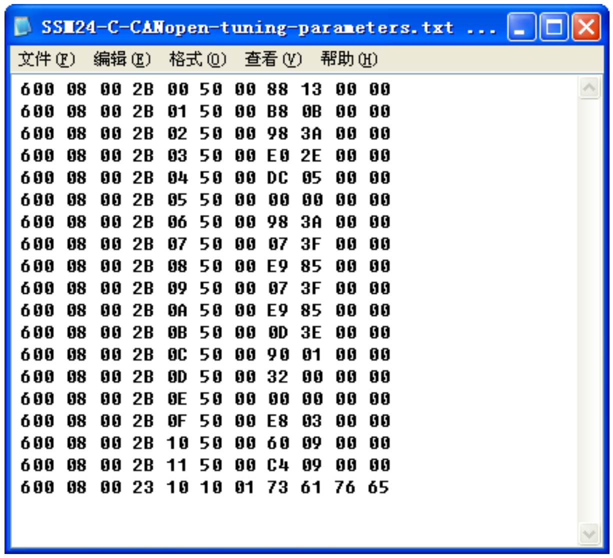
4.1.10.2 Move Profile Calculator

Move Profile Calculator provides an excellent tool for the customer to simulate move profiles. The motion parameters can convert between time and SCL parameters easily via click a button. When the drive is connected with the software, you can click "Test Profile" to try a move per your inputs.



4.1.10.3 Export CANopen Parameters

After tuning is done. Export CANopen Parameters provides a tool to export the tuning parameters such as KP , KD, VP, VI and etc. and save these parameters to a text file in a specific data format which is easy for the customer to immigrate to their program. Below is a saved file example.



```
SSM24-C-CANopen-tuning-parameters.txt ...
文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)
600 08 00 2B 00 50 00 88 13 00 00
600 08 00 2B 01 50 00 B8 0B 00 00
600 08 00 2B 02 50 00 98 3A 00 00
600 08 00 2B 03 50 00 E0 2E 00 00
600 08 00 2B 04 50 00 DC 05 00 00
600 08 00 2B 05 50 00 00 00 00 00
600 08 00 2B 06 50 00 98 3A 00 00
600 08 00 2B 07 50 00 07 3F 00 00
600 08 00 2B 08 50 00 E9 85 00 00
600 08 00 2B 09 50 00 07 3F 00 00
600 08 00 2B 0A 50 00 E9 85 00 00
600 08 00 2B 0B 50 00 0D 3E 00 00
600 08 00 2B 0C 50 00 90 01 00 00
600 08 00 2B 0D 50 00 32 00 00 00
600 08 00 2B 0E 50 00 00 00 00 00
600 08 00 2B 0F 50 00 E8 03 00 00
600 08 00 2B 10 50 00 60 09 00 00
600 08 00 2B 11 50 00 C4 09 00 00
600 08 00 23 10 10 01 73 61 76 65
```

4.1.10.4 CANopen Test Tool

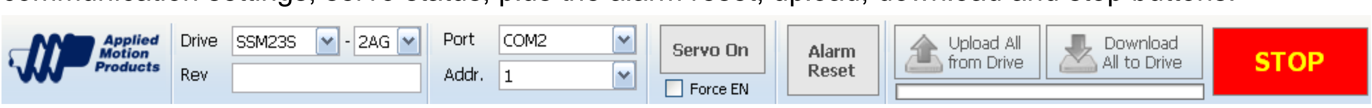
This provides a quick link to the installed CANopen Test Tool software.
If you have installed CANopen Test Tool, click this will launch “CANopen Test Tool” software.

4.1.11. Language

Language button has 2 language options. You can click one of them to shift the language between English and Chinese.

4.2. Tool Bar

The Tool Bar includes the Applied Motion Products logo, drive model, drive firmware revision, communication settings, servo status, plus the alarm reset, upload, download and stop buttons.



4.2.1. Drive Model

The Drive drop-down list shows all of the available step servo drive model numbers.
The Revision window will display a drive's firmware version once the drive is properly connected to the PC and power is supplied.

4.2.2. Communication Port

Choose the correspondent communication port for the drive before any drive configuration. For RS-485 drives, it allows you to choose the address of the drive to which you wish to connect.

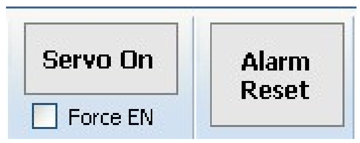
4.2.3. Servo Status

The servo enable switch is used to enable and disable the motor status. It also displays the current status: when the button is green, the motor is enabled.

"Force EN" allows you enable the motor when a drive is connected to *Step Servo Quick Tuner* regardless of the external enable input status.

Alarm reset allows you to reset the alarm, when they occurs.

NOTE: Alarms can only be cleared when the drive's warning or fault problems are solved.

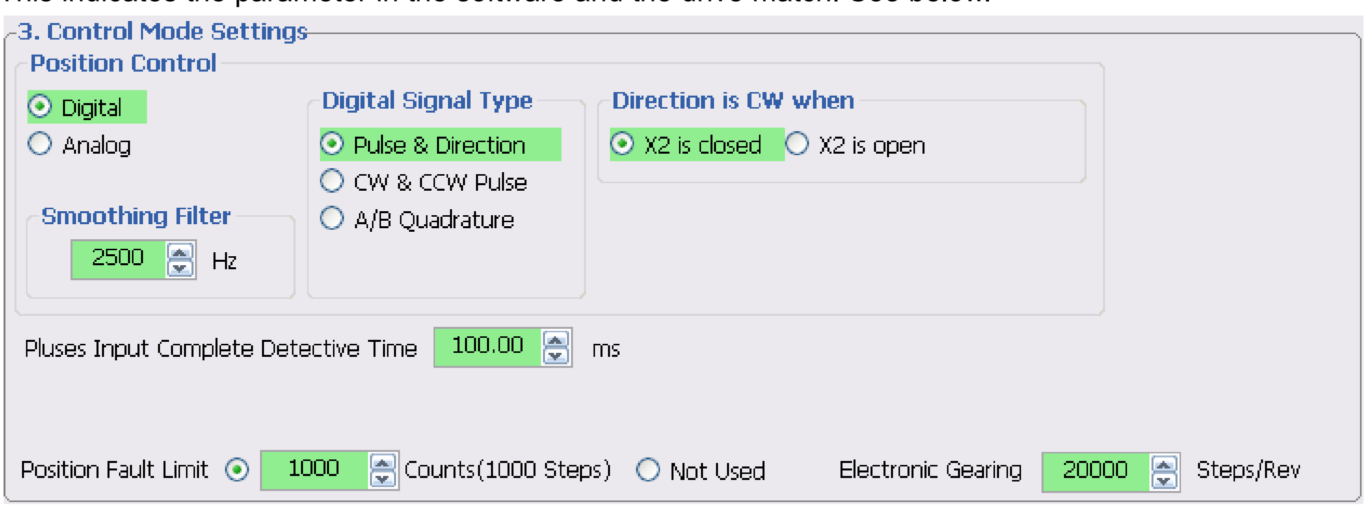


4.2.4. Upload and Download

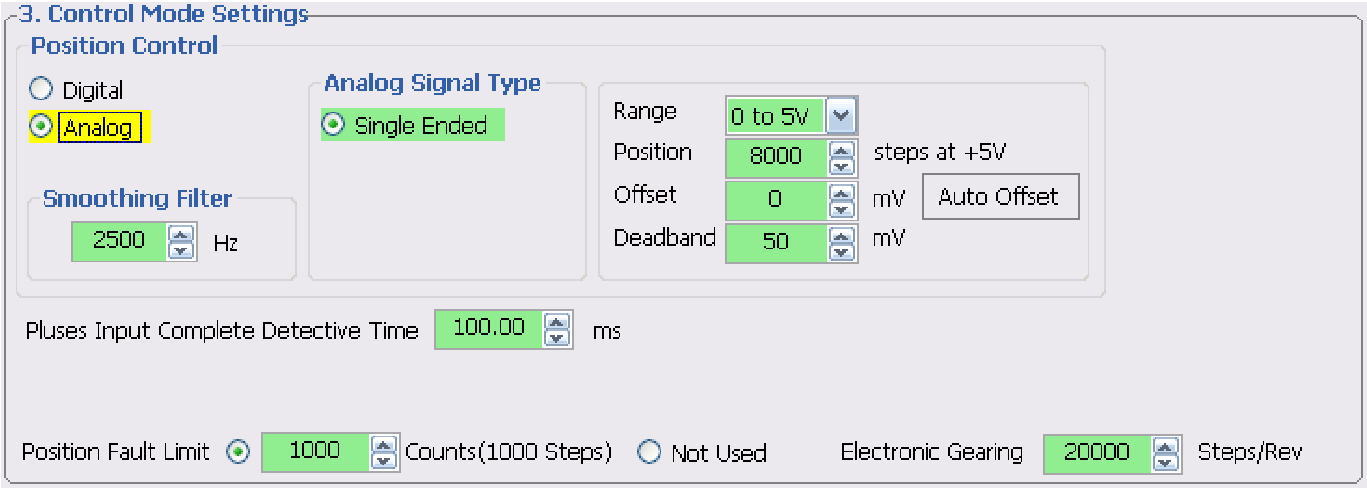
Upload lets you copy the set up and tuning parameters from your Step Servo motor into *Step Servo Quick Tuner*. This is useful if you want to make changes to a system that has already been tuned.

The Download button is used to copy settings from *Step Servo Quick Tuner* to your drive. Use this if you make a change to a drive setting and want to transfer the information back to the drive.

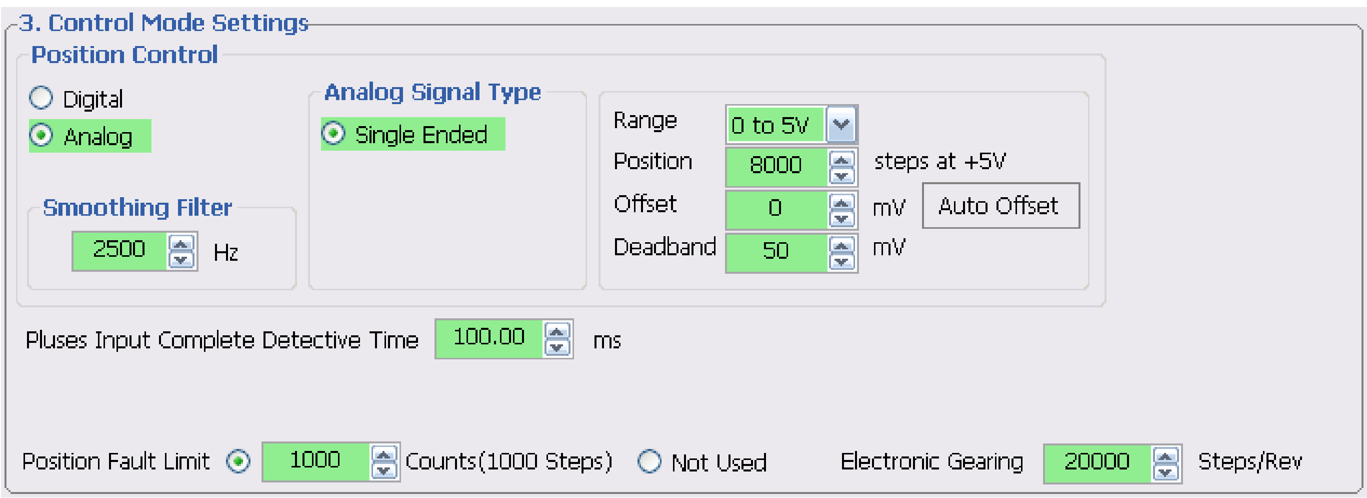
"Upload All from Drive" and "Download All to Drive" will upload or download the whole project.
After performing an upload or download, the background of each parameter will change to a green color. This indicates the parameter in the software and the drive match. See below.



Then if a parameter is changed, the background of that parameter will change to yellow. This indicates the parameter in the software and the drive differs. See below.



Then if a download is performed after that parameter changes, the background of that parameter will change back to green. This indicates the parameter is downloaded successfully and the software and drive are again synchronized. See below.



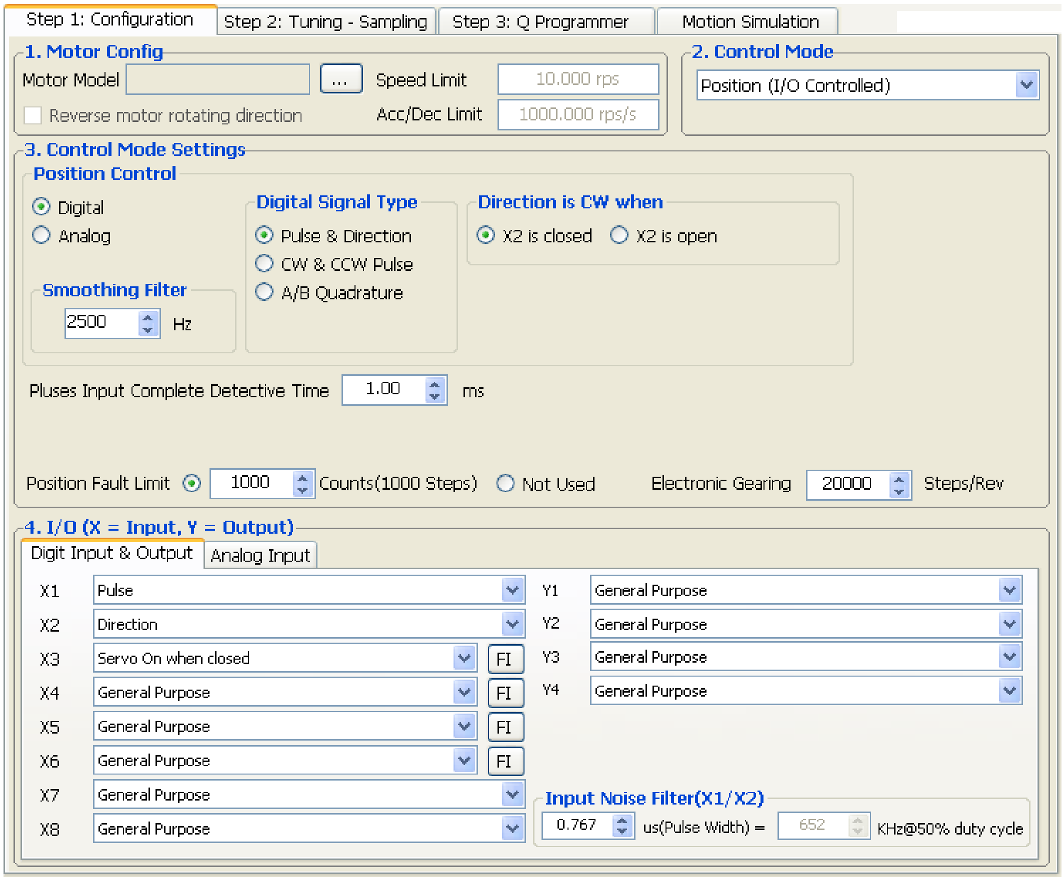
If the driver is not powered up and connected to the software, or an upload or download has not been performed, the background color of the parameter is transparent or white, which means the software and driver have not been synchronized (by upload or download).

4.2.5. Stop

Stop drive's motion immediately.

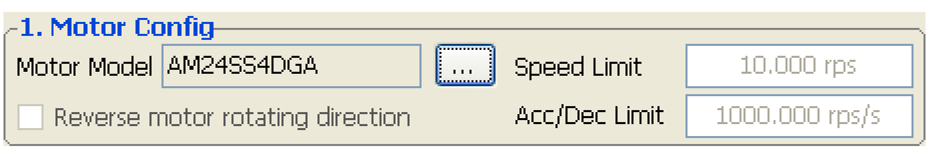
5 Step 1: Drive Configuration

In this tab, you can configure drive's settings and control mode in detail.

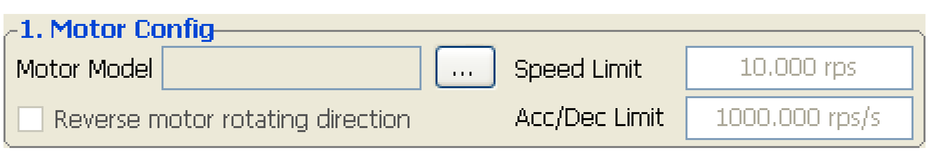


5.1 Motor Configuration

SSM, TSM andTXM Step Servo products are integrated motors which have a fixed motor model. Only SS/SSAC Step Servo series allow the user to select different motor models.

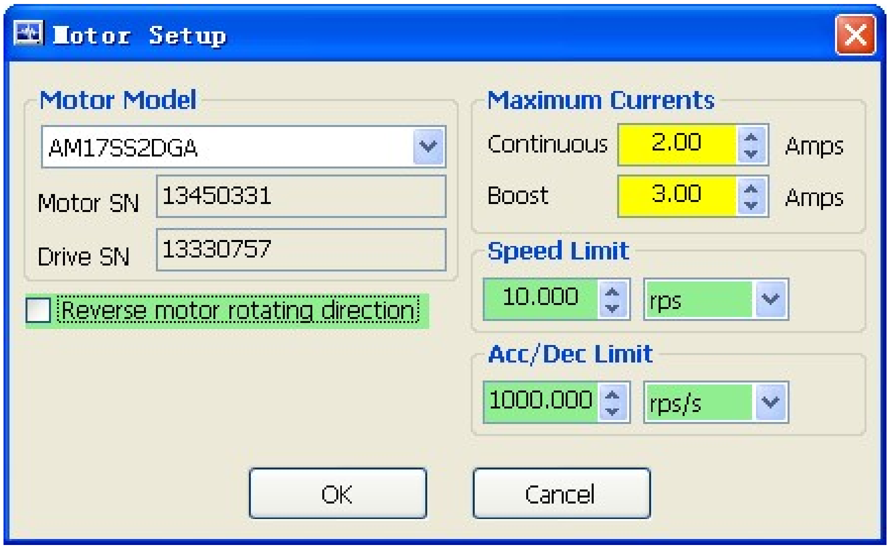


The integrated step servo models (SSM,TSM, and TXM) appear as follows;



Click "…"to activate the Motor Setup dialog. In this window maximum current, speed limit, and accel/decel limit can be set.

Checking the box marked "Reverse motor rotating direction" will reverse the default rotating direction of the motor (a power cycle is necessary before a change to this setting becomes active).



5.1.1 Maximum Currents

The drive current must be set to match the motor. First, determine the rated current for the motor according to your drive's hardware manual.

If you are manually setting the current, type the value into the Maximum Current text box.

The step servo drive provides a peak current momentarily. This will provide greater acceleration rates than would otherwise be possible. To assure reliable motor operation, the drive will automatically ramp the current down after one second so that the average current does not exceed the motor's rating. Never continuously operate a step servo motor above its rated current.

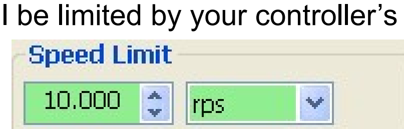
The peak current available varies from model to model, so check your product specifications before setting a value.

5.1.2 Maximum Speed

Here you can enter the maximum speed allowable in your application. If you attempt to command a speed that is higher than the maximum speed setting, the final speed achieved will be the speed set in the maximum speed parameter.

Note: Maximum Speed works with Velocity Mode and Torque Mode Only.

In Pulse Input Mode these values will be limited by your controller's software.

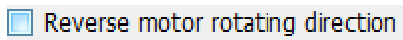


5.1.3 Maximum Acceleration

This will set the maximum level of acceleration for the motor. Even if the command input tries to demand a higher level of acceleration, the drive will only accelerate or decelerate at the maximum set level.

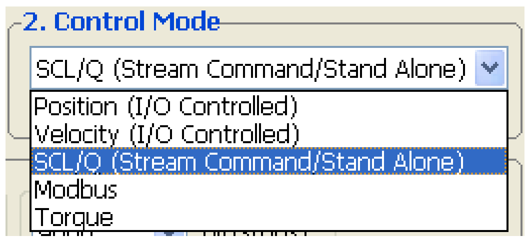
5.1.4 Reverse motor rotating direction

If this is checked, the motor rotating direction will be reversed without any other changes.



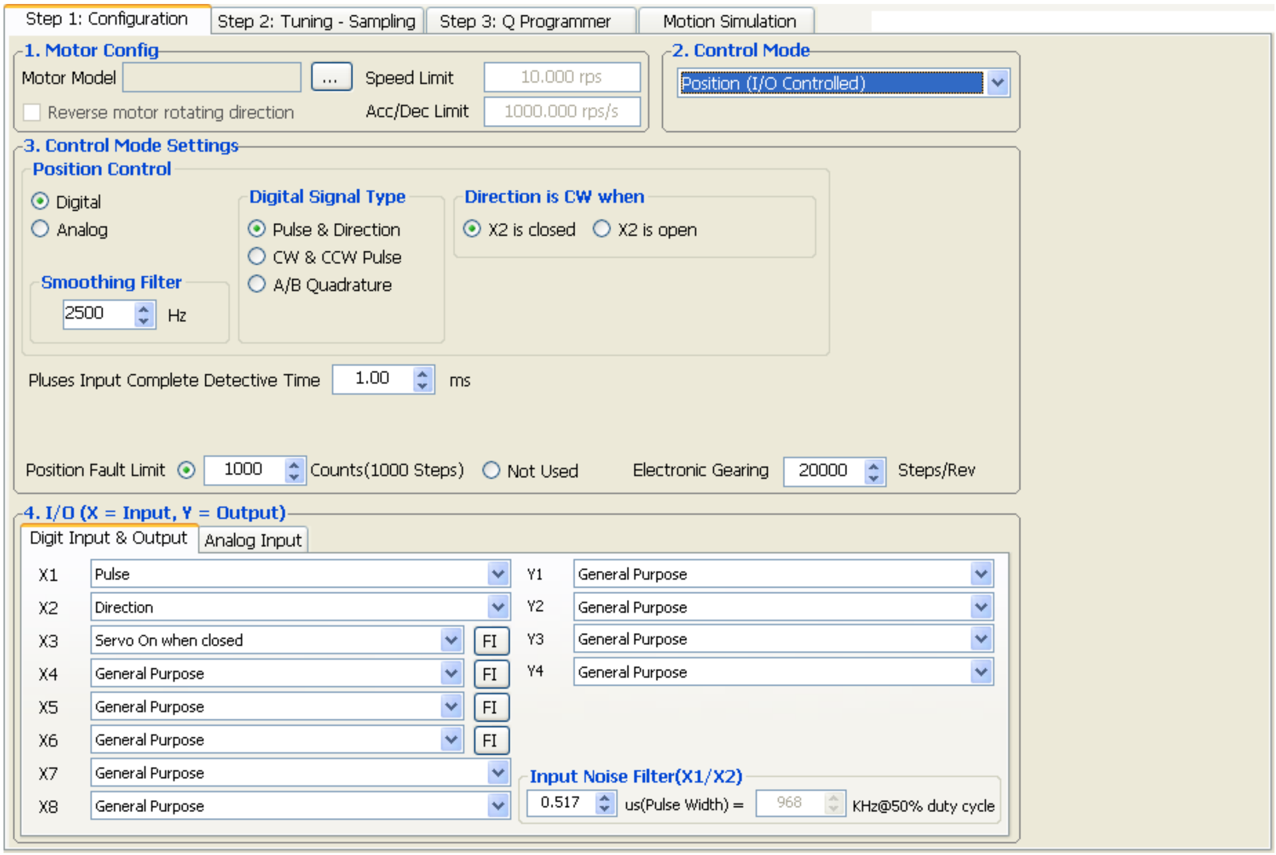
5.2 Control Mode Selection

Applied Motion Products' drives support many control modes. You can select a control mode from the control mode list, as shown below:



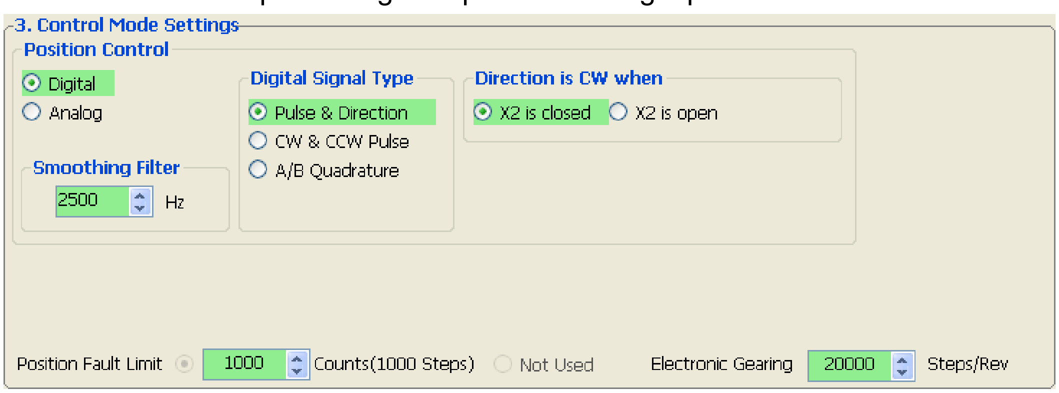
5.3 Control Mode Settings

Some drives allow the user to select from a number of different operating modes. This may be either selecting from a type of command signal or selecting between different programming modes.
The particular modes available will depend on the drive model. If you have your drive connected and it has been detected by *Step Servo Quick Tuner*, only the options available on your drive will be shown. Alternatively, by selecting your model from the drop down list at the top of the screen the options screen for your drive will be displayed.



5.3.1 Position Mode (I/O Controlled)

Position mode has two control options: digital input and analog input.



5.3.1.1 Position Control - Digital

Pulse Input Mode is for systems where the position of the motor is determined by a digital input signal in the form of step pulses combined with another input signal that controls the motor direction. This is also known as “step direction mode”.

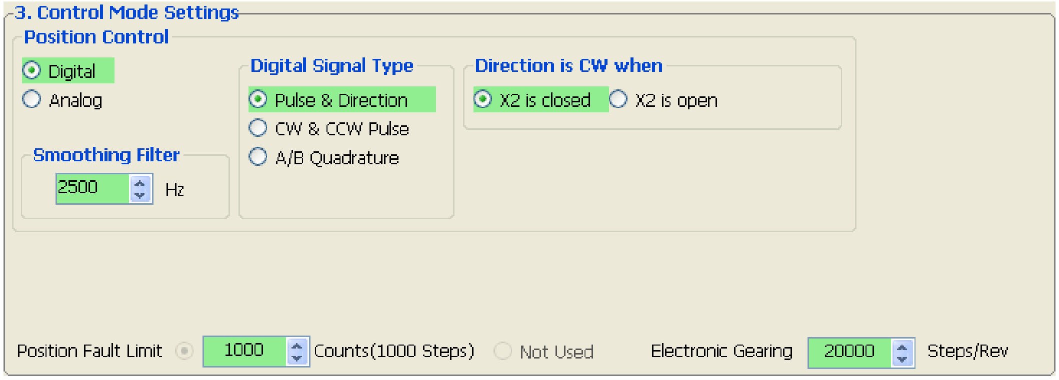


Fig 3.10 Digital Settings in Position Mode

The three modes available are:

***Pulse and Direction*.** Accepts a signal from a motion controller or PLC. With this mode the frequency of the pulses fed into one input (X1) determines the speed and position, while the direction of rotation is determined by a signal fed into another input (X2). You can configure whether the X2 signal should be closed or open to command clockwise motion.

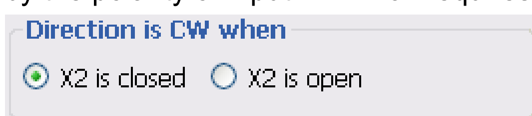
***CW and CCW Pulse*.** The motor will move CW or CCW depending on which input the pulse is fed into. The drive has two inputs allocated to this feature (X1 and X2); pulses fed into one input will generate CW motion and pulses fed into the other input will generate CCW motion.

***A & B Quadrature*.** Sometimes called “Slave Mode”. The motor will move according to signals that are fed to the drive from a master encoder. This encoder can be mounted on a shaft on the machine or it can be another motor in the system. Using quadrature input mode it is possible for a number of motors to be “daisy chained” together with the encoder output signal from each drive being fed into the next.

For all the Pulse Input modes you will need to determine a value to enter into the Electronic Gearing box. An explanation on how to do this is given in the next section.

Direction is CW when

CW direction is determined by the polarity of input X2 which requires to be set in priority.



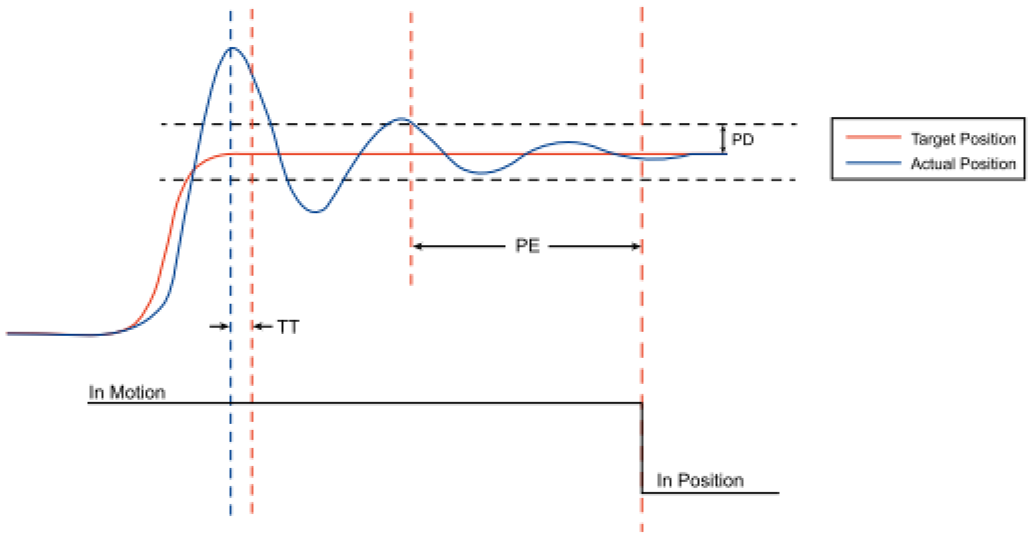
Smoothing Filter

Setting the electronic gearing (EG) to a low value (typically less than 2000 steps/rev) can result in rough motion, so set the electronic gearing to a high value if possible. Some PLC’s and motion controllers have a limited maximum pulse rate, so achieving a high move speed is only possible by setting EG to a low value. In such cases, smooth motion can still be achieved by using the Step Smoothing Filter.

1) Smaller values give smoother performance.
2) Smoothing filter technology will introduce a time delay; this doesn’t the positioning accuracy at the end of a move but can cause the actual motion to lag behind the command signal during the move.

Pulse Input Complete Detection Time

Sets a period of time during which, if the drive doesn't receive any more pulses, the move is considered to be complete. This parameter is used for determine whether the motor is in position or not. See detailed information on the TT command in the *Host Command Reference.*



5.3.1.2 Position Control - Analog

Analog position control instructs the step servo motor to position the motor according to an analog input command. For example, the configuration below would cause the motor to move 8000 counts clockwise from its current position if the voltage applied to the analog input changes from 0 volts to 5 volts. If the signal then changed to 2.5 volts, the motor would move 4000 counts CCW.

There is also option for an offset voltage and a dead band. The offset can be used to offset the position in case the 0 volt signal from your analog command does not represent zero position on your application.

TUNING NOTE: Turning off the KD (differential gain) term will minimize analog noise affects. The higher the "Position" gain setting the more analog noise will cause dithering.

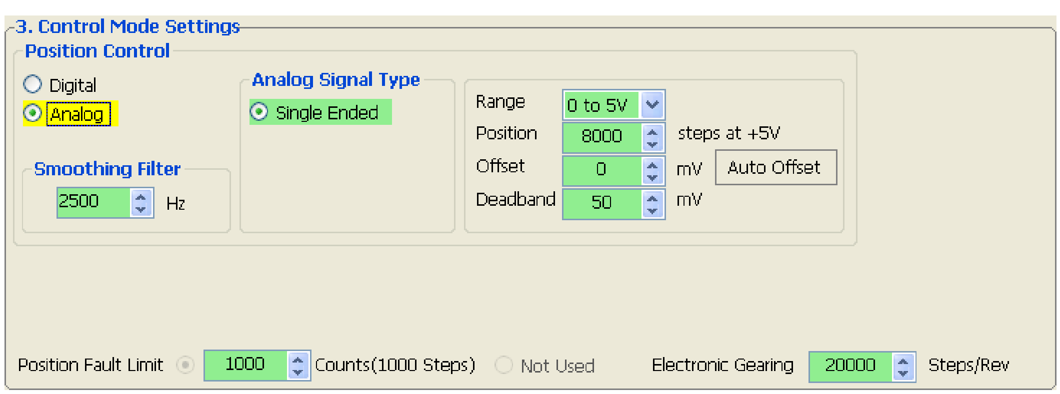
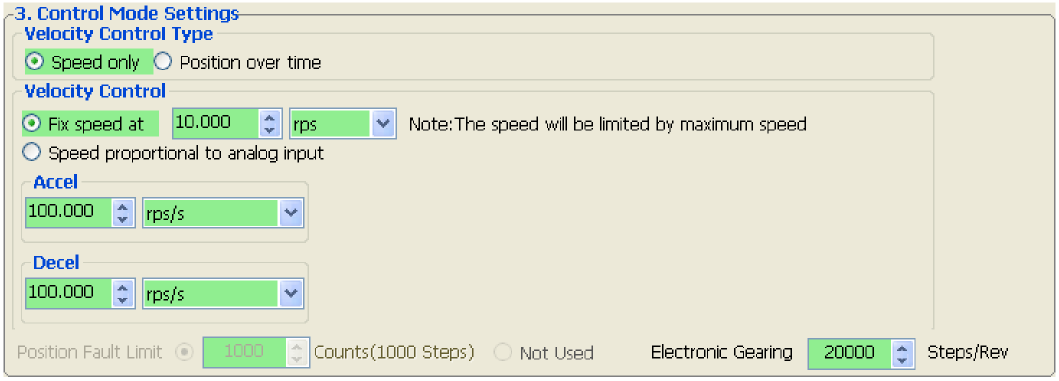


Fig. 3.9 Analog Settings in Position Mode

5.3.2 Velocity Mode (I/O Controlled)

Velocity mode means that the drive uses the command input signal to set the motor speed.



Some options are needed in velocity mode.

Velocity Control Type: “Speed Only” (without position error) or “Position over time” (With position error check)

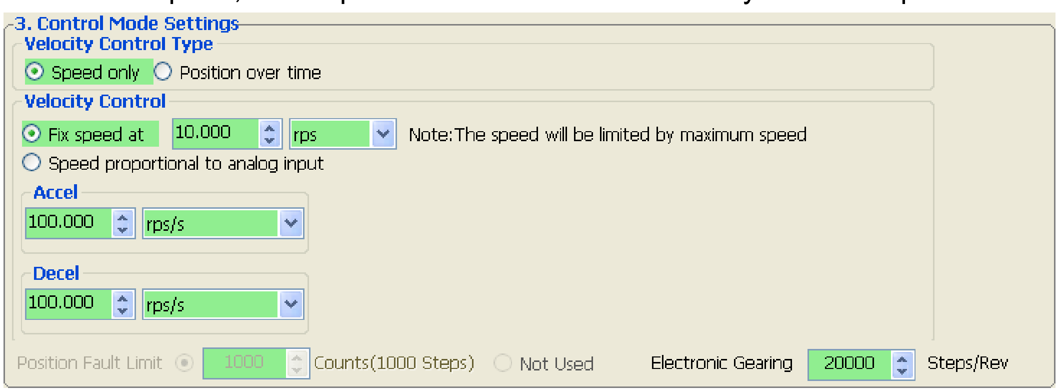
Velocity Control: Chooses whether the motor speed is fixed is proportional to the analog input voltage

Accel: Sets the acceleration in velocity mode.

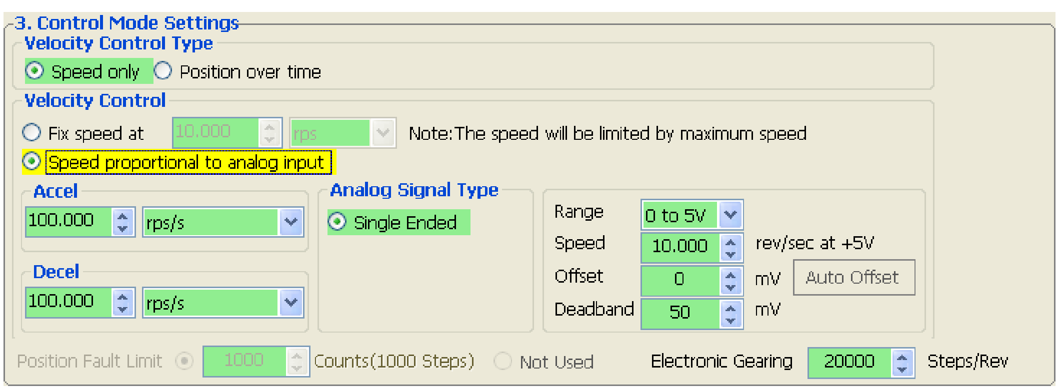
Decel: Sets the deceleration in velocity mode.

5.3.2.1 Fixed Speed

Motor will run at a fixed speed, run/stop and direction are controlled by external inputs.



5.3.2.2 Analog Velocity Mode



The box labeled “Speed” enables you to define the speed that the motor will reach with the given analog settings. For example, if the speed is set to 10 rev/sec the motor will spin in the clockwise (CW) direction at 10 revolutions per second when the analog input signal is 5V. If the analog signal is set to 1 volt, the motor speed would be 2 rev/sec.

By setting the Speed to the maximum for your application, and not the maximum speed of the motor, you will achieve higher resolution on the command input and better control.

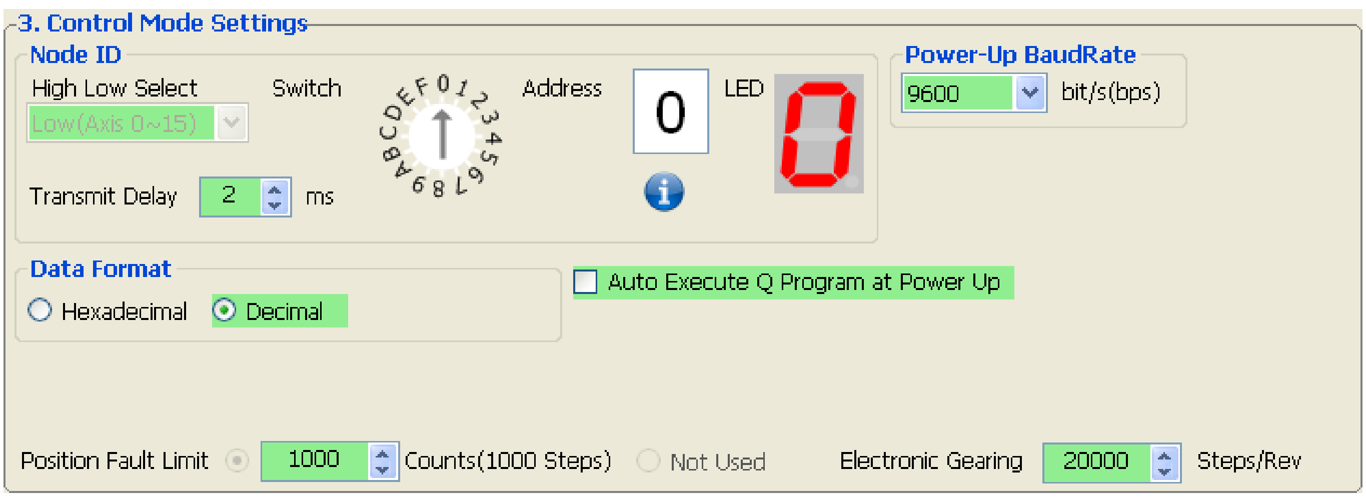
The speed value can be entered as a negative value. This will allow you to select which direction the motor will run with a positive command signal voltage.

5.3.3 SCL /Q Mode (Streaming Commands/Stand Alone)

5.3.3.1 SCL

SCL or serial command language was developed by Applied Motion Products to give users a simple way to control a motor drive via a serial port. This eliminates the need for separate motion controllers to supply control signals, like pulse & direction, to your drive. It also provides an easy way to interface to a variety of industrial devices like PLCs, industrial computers, and HMIs, which most often have standard or optional serial ports for communicating to other devices.

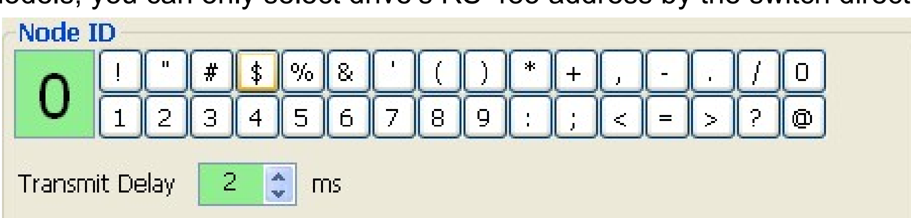
SCL a host controller to send instructions to drives in real time. With SCL, the drives can be operated in RS-232 or RS-485 mode; the RS-485 option allows you to have multi-axis multi-drop applications with the drives “daisy chained” on one serial link. When this option is selected you will need to set an address for each drive that will share the network. Refer to Setting the Address in the next section.



Node ID

In SCL mode with RS-485 communications you will need to set the address for each drive in your system. Simply select the address character and perform a download; in this way up to 32 drives can be connected together on a single serial link.

For some drive models, you can only select drive’s RS-485 address by the switch directly on the drive.



Transmit delay

This sets up the transmit delay for communications between host controller and the drive. This is highly necessary for 2 wire configurations for RS-485 communication. The host must disable its transmitter before it can receive data. This must be done quickly before a drive begins to answer a query.

Baud rate

At power up, a drive will send a "power-up packet" to see if it can find the *Step Servo Quick Tuner* software. If, after one second, it does not receive a response from *Step Servo Quick Tuner,* the drive will enter SCL or Q operation, depending on the PM setting. The drive will set the baud rate according to the value stored in the Baud Rate NV parameter. Changing this parameter will take effect on the next drive power up.

Data format

This sets the numeric format for SCL immediate queries like IV and IT. You can choose hexadecimal and decimal. See the *Host Command Reference* for details.

Auto Execute Q Program at Power Up

If this is checked, the drive will execute stored Q program from segment 1 automatically at power up.

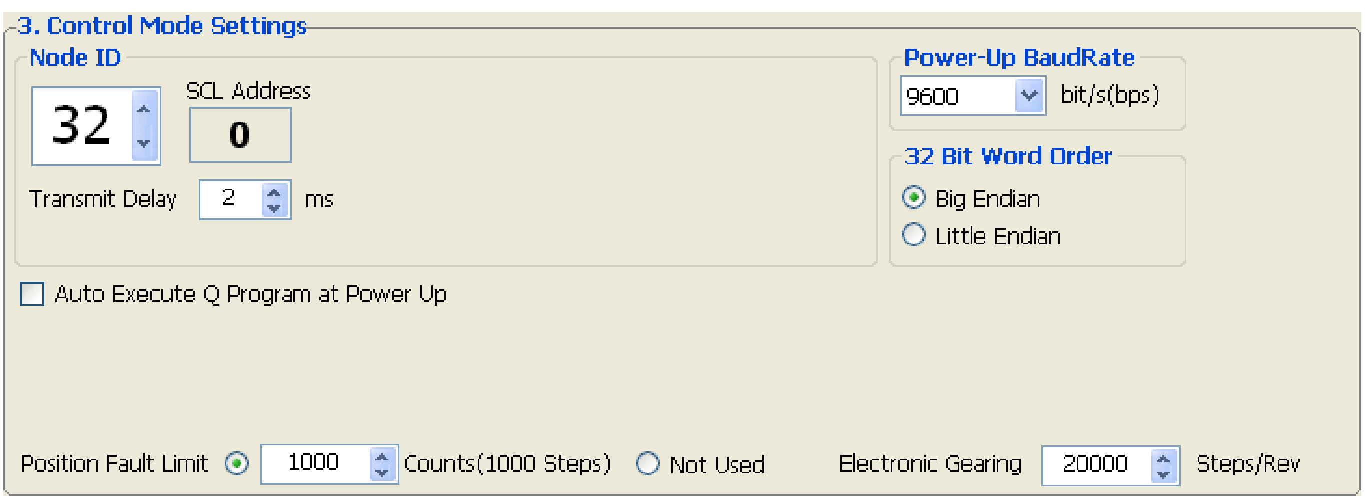
5.3.3.2 Q Program

The Q language is a superset of the SCL streaming language that allows a user to compose programs that can be stored and executed in the drive. These programs are saved in a drive's non-volatile memory, and the drive can run these programs stand-alone, or with a connection to a host. The drive can be configured to automatically run the Q program at power up, or to wait for instructions from a host, which can start and stop the program on demand. Q programs can also be started and stopped using fieldbus commands in CANopen and EtherNet/IP models.

By combining the ability to run a sophisticated, single-axis motion control program stand-alone with the ability to communicate serially to a host device, Q drives offer a high level of flexibility and functionality to the machine designer and system integrator, with available commands for motion control, multi-tasking, conditional processing, math calculations, and data register manipulation.

Q programming is described in detail in the *Host Command Reference*.

5.3.4 Modbus/RTU



Node ID

In a networked system, each drive requires a unique address. Only the drive with the matching address will respond to the host command. In a Modbus network, address "0" is the broadcast address. It cannot

be used as an individual drive's address. Modbus RTU drives can drive addresses from 1 to 32. Applied Motion step servo drives use the same address for SCL and Modbus, but in a slightly different way for each. The relationship between the Modbus Node ID and the SCL address character is shown in the table below.

Node ID	1	2	3	4	5	6	7	8
SCL Address	1	2	3	4	5	6	7	8
Node ID	9	10	11	12	13	14	15	16
SCL Address	9	:	;	<	=	>	?	@
Node ID	17	18	19	20	21	22	23	24
SCL Address	!	"	#	$	%	&	'	(
Node ID	25	26	27	28	29	30	31	32
SCL Address	)	*	+	,	-	.	/	0

Auto Execute Q Program at Power Up

If this is checked, the drive will execute stored Q program from segment 1 automatically at power up.

32 bit word order

Big-endian: The most significant byte (MSB) value is stored at the memory location with the lowest address; the next byte value in significance is stored at the following memory location and so on. This is akin to left-to-right reading in hexadecimal order.

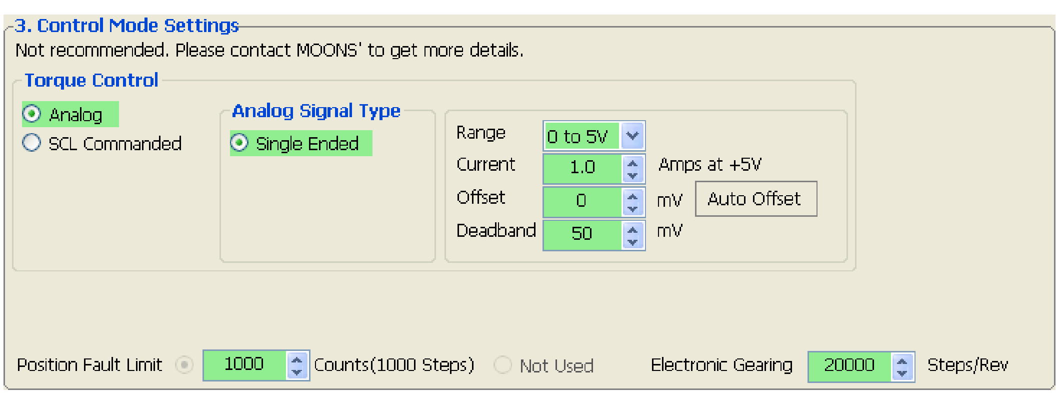
Little-endian: The most significant byte (MSB) value is stored at the memory location with the highest address; the next byte value in significance is stored at the following memory location and so on. This is akin to right-to-left reading in hexadecimal order.

When setting up a Modbus network, be sure to check the word order of your host device, then set your step servo drive to match. If the word order (also called endianness) does not match, the motor will move much farther than you command.

5.3.5 Torque Mode

When the drive is set up for Torque mode, it allows you to define the current that will be delivered and thus the torque generated by the motor and the direction it will rotate. In this mode the speed that the motor runs at will depend on the load applied to the motor.

WARNING - If the motor is not connected to the load or has no load applied, downloading this mode while there is a command signal present may cause the motor to accelerate to a high speed.



Torque mode has two control types, Analog and SCL Commanded.

5.3.5.1 Analog

Torque mode has two analog input options: single ended and differential.

There are four settings that are required for getting the analog inputs to control the desired mode output:

1. Range – For SSM, TSM and TXM integrated motors the range is fixed at 0 to 5V; for SS and SSAC drives the range has 4 options: ±10V, 0 to 10V, ±5V, and 0 to 5V.

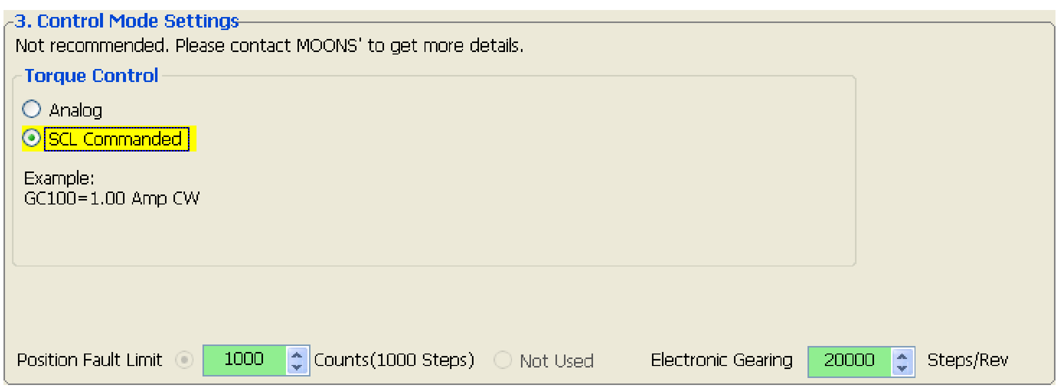
2. Current – Establishes a gain value that scales the input voltage to the output current. For example in Current Mode (Torque mode), if "Current" is set to 5, a 5 volt input will apply 5 amps to the motor. A 2 volt input will apply 2 amps to the motor.

3. Offset – Sets an offset value to the input that can null out a voltage bias or shift the input voltage value as needed. Often in analog systems it is difficult to get a true "0" value. Using the offset feature allows you to adjust out any unwanted offsets that disturb the desire for a true 0 volt input from an external controller. The "Auto Offset" function can automatically detect and correct voltage biases on the input. Click the button and follow the instruction to accomplish this task.

4. Dead band – Inserts a voltage region where the input is seen as "0". Because of the sometimes imprecise nature of analog signals and input circuitry there may be a need to create a "dead" zone where the analog input has no effect on the output. This is normally needed around the "0" input. For example, when using a joystick to operate the motor the user may not want any torque output when the Joystick is at its "Null" position. Most joysticks are somewhat imprecise and may produce a small voltage at the neutral, adding a dead band can eliminate the effect of the small voltage.

5.3.5.2 SCL Commanded

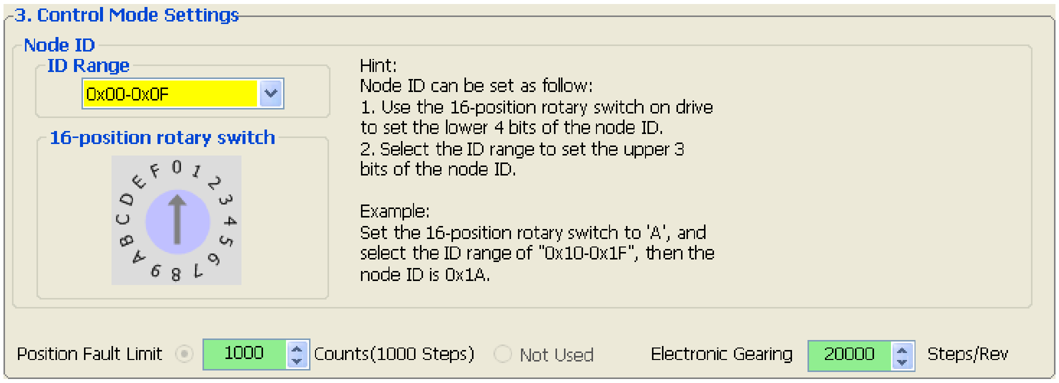
SCL commanded torque mode works by accepting SCL GC commands from a host to control the motor's output torque.



5.3.6 CANopen

CANopen is a communication field bus standardized by the CAN in Automation Group (CiA). Applied Motion Products drives are compliant to CiA 301 and CiA 402 and use the CAN 2.0B passive physical layer.

Detailed information on the Applied Motion Products CANopen implementation can be found on our website.



Node ID

In a CANopen network, each drive needs to have a unique node ID. CANopen node ID addresses are represented as 7 bit binary numbers, ranging from 1 to 127 (hexadecimal 0x01 to 0x7F).

For Applied Motion drives, the low 4 bits of the node ID are set by the switch on the drive, and the upper 3 bits must to be set by *Step Servo Quick Tuner*.

TXM drives do not have rotary switch. The Node ID and CANopen Baud rate are all set by Step Servo Quick Tuner.

5.3.7 Positioning Error Fault & Electronic Gearing

5.3.7.1 Positioning Error Fault

Positioning error is the difference, in encoder counts, between the actual position and the commanded position of the motor. A small amount of positioning error is a normal part of a servo system. But sometimes the unexpected can happen. A wire might break, a sensor could fail or the motor may encounter a physical obstruction. You might even one day forget to set up and tune a drive before installing it into a system. In all of these cases, you'll want to know that something is wrong as soon as possible and without damaging anything. For this reason, the step servo drives include a position error fault limit. Anytime the position error (as reported by the encoder) exceeds this limit, the drive cuts power to the motor.

You can set the fault limit to as little as 10 encoder counts, or as much as 32000. When you're first tuning the system, you should set this value high or select "Not Used" so that the drive doesn't shut down as you experiment with tuning parameters. Once the drive is properly tuned and you know how much error to expect during normal operation, you can set an appropriate fault limit. For example: set *Step Servo Quick Tuner's* scope to plot position error. Execute some aggressive sample moves, using the maximum speed and acceleration that you plan to use in your application. If the maximum position error is, say, 50 counts, then you could safely set the fault limit at 100.

5.3.7.2 Electronic Gearing

Electronic Gearing allows you to adjust the way that the drive responds to incoming step pulses. This is very useful if you are replacing a step motor drive with a step servo system, because you can make the drive have the same number of steps/revolution as the stepper. For example, you may have an 8000 count

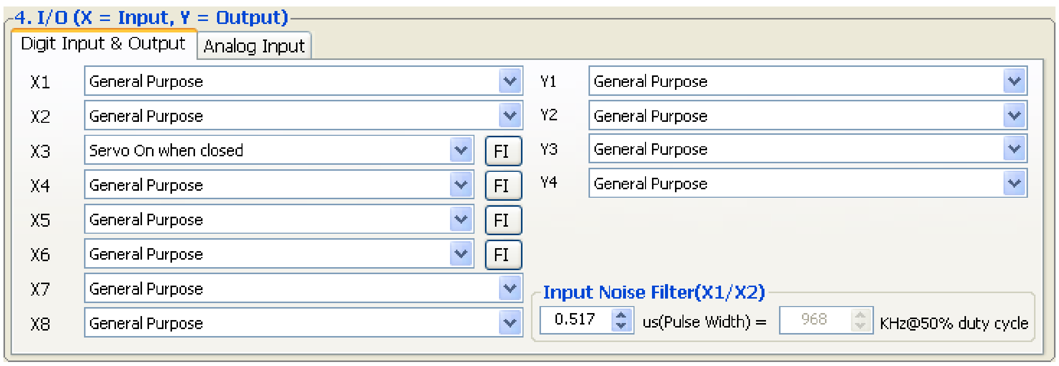
encoder, but want the drive to operate at 200 steps/rev, like a full step drive. Or perhaps the system is working in degrees, so you want to operate the drive at 36,000 steps/rev so that there is an even number of steps (100) per degree.
Simply enter the number of steps/rev you want in the “Electronic Gearing” text box.

5.4 I/O Configuration

I/O configuration includes digital I/O configuration and analog input configuration.

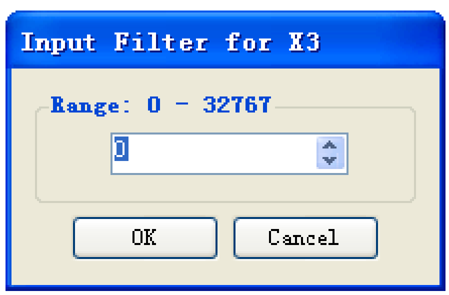
5.4.1 Digital I/O Configuration

Digital I/O configuration is to configure the digital inputs(X) and digital outputs(Y).



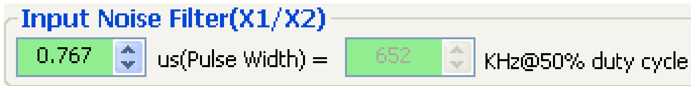
5.4.1.1 FI Input filter

Applies a digital filter to a given input. The digital input must be at the same level for the time period specified before the input state is updated. For example, if the time value is set to 100 the input must remain high for 100 processor cycles before the input state is consider to be high. One processor cycle is 200 μsec for a Step Servo drive. A value of “0” disables the filter.

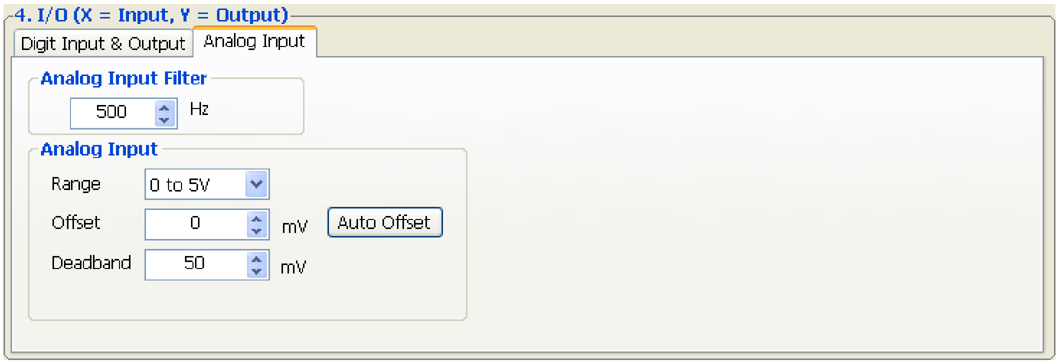


5.4.1.2 Input Noise Filter

The Input Noise Filter acts as a low-pass filter, rejecting noise above the specified frequency. Set the Pulse Width, the software will calculate the frequency.



5.4.2 Analog Input



5.4.2.1 Analog Input Filter

The analog input filter sets the frequency in hertz of the roll off point of a single pole low pass filter. When using any of the analog Input modes, this filter can be used to reduce the affects of analog noise on the mode of operation.

5.4.2.2 Analog Input Settings

1. Range – For SSM, TSM and TXM integrated motors the range is fixed at 0 to 5V; for SS and SSAC drives the range has 4 options: ±10V, 0 to 10V, ±5V and 0 to 5V.

2. Offset – Sets an offset value to the input that can null out a voltage bias or shift the input voltage value as needed. Often in analog systems it is difficult to get a true "0" value. Using the offset feature allows you to adjust out any unwanted offsets that disturb the desire for a true 0 volt input from an external controller. The "Auto Offset" function can automatically detect and correct voltage biases on the input. Click the button and follow the instructions to accomplish this task.

3. Dead band – Inserts a voltage region where the input is seen as "0". Because of the sometimes imprecise nature of analog signals and input circuitry there may be a need to create a "dead" zone where the analog input has no effect on the output. This is normally needed around the "0" volts. For example, when using a joystick to operate the motor the user may not want any torque output when the joystick is at its "Null" position. Most joysticks are somewhat imprecise and may output a small voltage at the neutral position; adding the dead band can eliminate the effect of the small voltage.

6 Step 2: Tuning - Sampling

6.1 Introduction

Like most modern servo drives, ours employ sophisticated algorithms and electronics for controlling the torque, velocity and position of the motor and load.

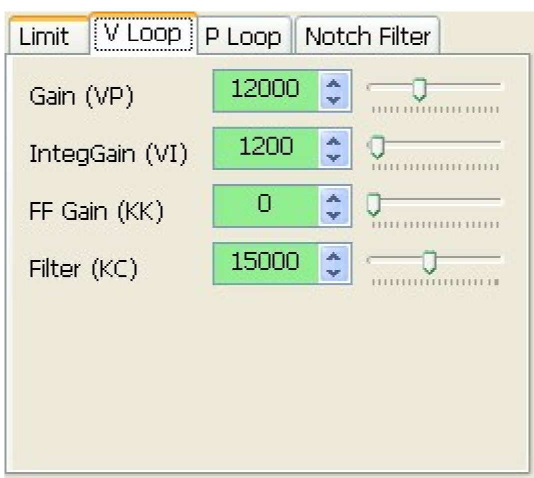
Sensors are used to tell the drive what the motor is doing. That way, the drive can continuously alter the voltage and current applied to the motor until the motor does what you want. This is called “closed loop control.”

One of the control loops controls the amount of current in the motor. This circuit requires no adjustment other than specifying the maximum current the motor can handle without overheating.

Step servo drives employ two control loops for the actual motor motion. The first is a velocity loop which is designed to control only the speed of the motor. The second is a position loop that controls the position of the motor. The current loop is contained inside the velocity loop, and the velocity loop is contained within the position loop. Good position loop control requires first tuning the velocity loop. As mentioned above, current loop tuning is not required as it is already optimized for the motor.

6.1.1 Velocity Control Loop (V Loop)

The velocity control loop is designed to operate the motor in a velocity-only type of servo control. This means that it can control the speed of the motor but cannot cause the motor to follow a commanded position. The jog commands available in the drive can employ only this loop for operation, which provides good stability even with very high inertia loads. Jogging can also use both the position and velocity loops. The JM (Jog Mode) command is available to set this feature or it can be configured when selecting the velocity control mode. Selecting the “speed only” control type causes the velocity loop alone to be used in the jog or velocity control functions. JM2 (Jog Mode 2) does the same. The “position over time” control type adds in the position control loop for precise position control during the move and when stopped. JM1 (Jog Mode 1) also selects this setting.
The velocity control loop has four terms that can be configured for optimum performance with a given load. This loop can be set and tuned independently of the position control loop. These control terms are described below.



6.1.1.1 Gain: The Velocity Proportional Term (VP)

The simplest part of the velocity loop is the proportional, or VP, term. The drive applies current to the motor in direct proportion to the velocity error. For example, if a motor is not moving, and the shaft is turned by hand or some other force, the drive will increase the motor current until the motor returns to “0” speed. The faster the motor is moved from “0” velocity, the more the opposing torque will increase. The VP term (also called VP gain) governs how much torque will be applied for a given amount of velocity error (Vn). In

general, more load inertia or load friction, requires more torque and therefore a higher VP gain. The torque provided by the VP term is:

$$T = VP * Vn$$

6.1.1.2 IntegGain: The Velocity Integral Term (VI)

In the previous example, applying the VP term alone will not result in perfect velocity control. If one ounce-inch of torque were applied to the motor, it would move at a slower speed. The VP term will increase the motor torque until it is producing as much torque as the force attempting to move it. The motor may slow down or even stop moving but there will still be error. The VI term adds up all the error the velocity calculation has reported and produces a torque that is added to the torque command from the VP term. The equation for this is:

$$T = VP * Vn + VI\Sigma(V)$$

In the example, the VP term allowed the motor to reach equilibrium at a speed where the applied torque equaled the torque of the VP term. Thus, the error was not zero. But the VI term continues adding up the error and increasing the torque until the motor returns to the true target position.

6.1.1.3 FF Gain: Acceleration Feed-forward Term (KK)

Larger loads typically generate larger load Inertia. These larger inertias can be more easily controlled by anticipating the system's torque need. The acceleration feed-forward term does this by adding an acceleration value to the torque command. The acceleration value is derived from the trajectory calculation during the acceleration and deceleration phase. As can be seen in the equation below this increased torque command is added with the VP and VI torque command values:

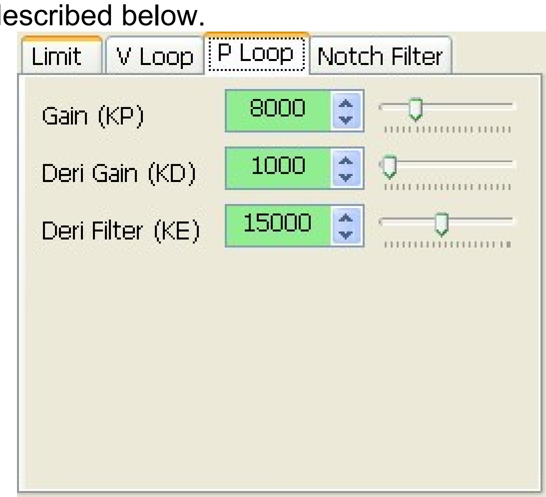
$$T = KK * A + VP * Vn + VI\Sigma(V)$$

6.1.1.4 PID Filter: Torque Command Filter Term (KC)

This fi nal term in the Velocity control loop can be considered an over-all fi lter term. In fact this term is always used even when the drive has been placed in the Torque Control Mode where only the current control loop is active. The fi lter is a very simple single-pole low pass fi lter that is used to limit the high frequency response of the velocity and therefore the position control loops.

6.1.2 Position Control Loop (P Loop)

The **Position Control Loop** is designed to provide the typical positioning control for a servo system. All positioning type operations use this loop including when operating in the **Pulse & Direction Position Control Mode**. The Position loop can also be used in the **Velocity Control Mode** when the **Position over time** control type option is selection or the Jog Mode is JM=1.
The Position Control Loop has three terms that can be configured for optimum performance with the given load. These control terms are described below.



6.1.2.1 Gain: The Position Proportional Term (KP)

The simplest part of the position loop is the proportional, or KP, term. The drive applies current to the motor in direct proportion to the position error. For example, if a motor is not moving, and the shaft is turned by hand or some other force, the drive will increase the motor current until the motor returns to the commanded target position (rest position). The farther the motor is moved from its target position, the more the torque will increase. The KP term (also called KP gain) governs how much torque will be applied for a given amount of error (Un). In general, more load inertia or load friction, requires more torque and therefore a higher KP gain.

Because of the topology of the control loops, the position control loop output is actually a velocity command that indirectly affects the torque command to the motor. The velocity command provided by the P term is:

$$V = KP * Un$$

6.1.2.2 The Position Integral Term (KI) - Not Implemented

There is no KI term as it is not required because of the velocity loop which contains an Integrator term. Any position error will taken up and corrected for in the velocity loop.

6.1.2.3 D Gain: The Derivative Term (KD)

A motor run with a pure PI controller would overreact to small errors, creating even larger errors and becoming unstable. By predicting what a motor will do ahead of time, the large errors and instability can be avoided. The derivative term determines this by analyzing the rate of change of the position error and including that in the torque calculation. For example, if the motor has a position error, but the rate of change of the error is decreasing, torque is lowered. The formula used here is:

$V = KP * Un + KD * (Un – (Un-1))$

where:

Un is the error in encoder counts

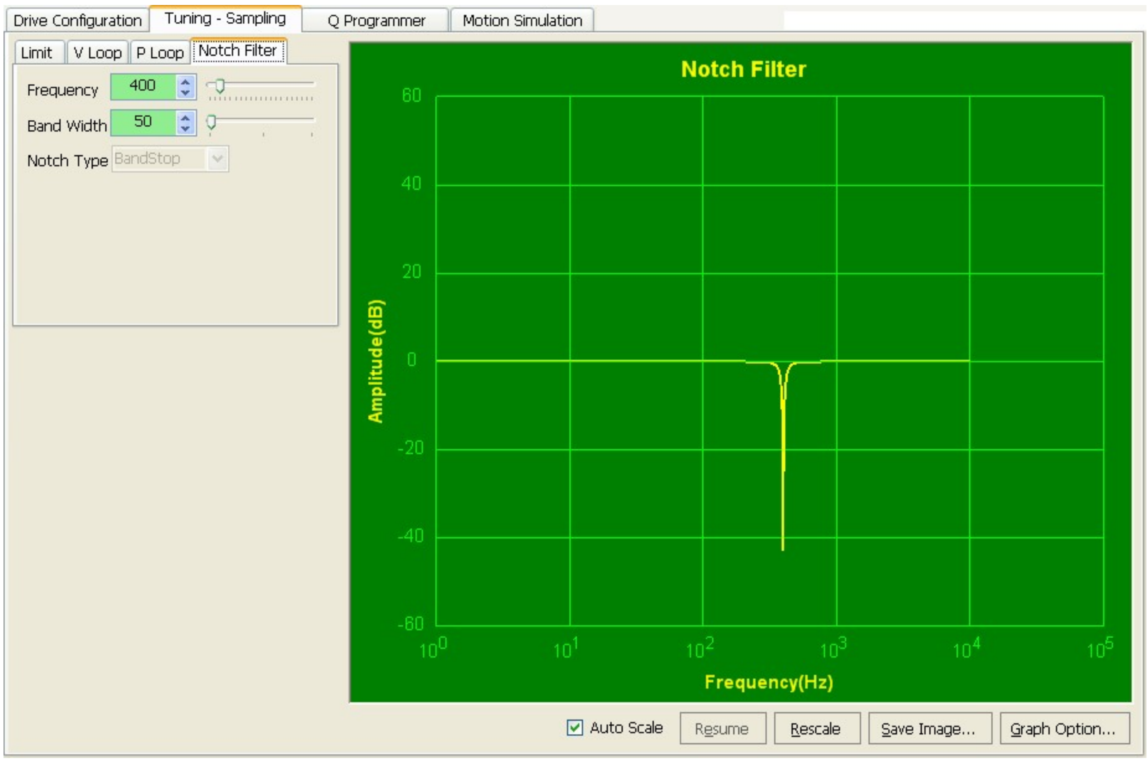
Un-1 is the error of the previous sample

6.1.2.4 D Filter: Torque Command Filter Term (KE)

A derivative control term can be rather noisy and even though it is effective in damping the positioning control, it can cause objectionable audible or observable noise to the system. The filter is a very simple single-pole low pass filter that is used to limit this high frequency noise and make the system quieter and more stable.

6.1.3 Notch filter

For additional filtering, an over-all notch filter is added to the current command signal. This filter is similar to the PID Filter in that it is active even when the drive is used in torque control mode. Notch filters are typically used to filter at a particular frequency when there is a resonant component in the mechanical system that may oscillate at that frequency. Couplers between the motor and the load can commonly do this which may result in a control problem. When gains are increased to improve performance the system may resonate in an uncontrollable manner. Then notch filter allows gain reduction at only the problematic resonant frequency, allowing the over-all gain to be set higher for better system control.
The notch filter has two parameters that are described below. The notch filter can only be configured though the *Step Servo Quick Tuner* interface where the *Step Servo Quick Tuner* software calculates the filter constants used by the drive.



6.1.3.1 Frequency: Notch Filter Center Frequency

This defines the center frequency - the frequency where the most gain reduction occurs. For now, finding the center frequency is a bit of a guessing game and different frequencies can be tried until the system resonance is eliminated.

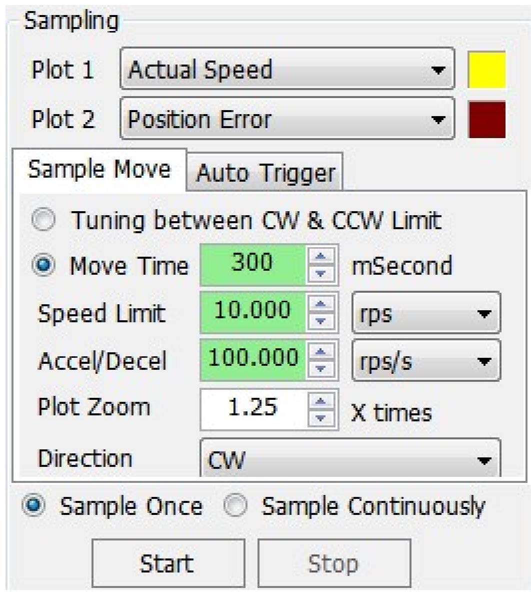
6.1.3.2 Bandwidth: Notch Filter Frequency Bandwidth

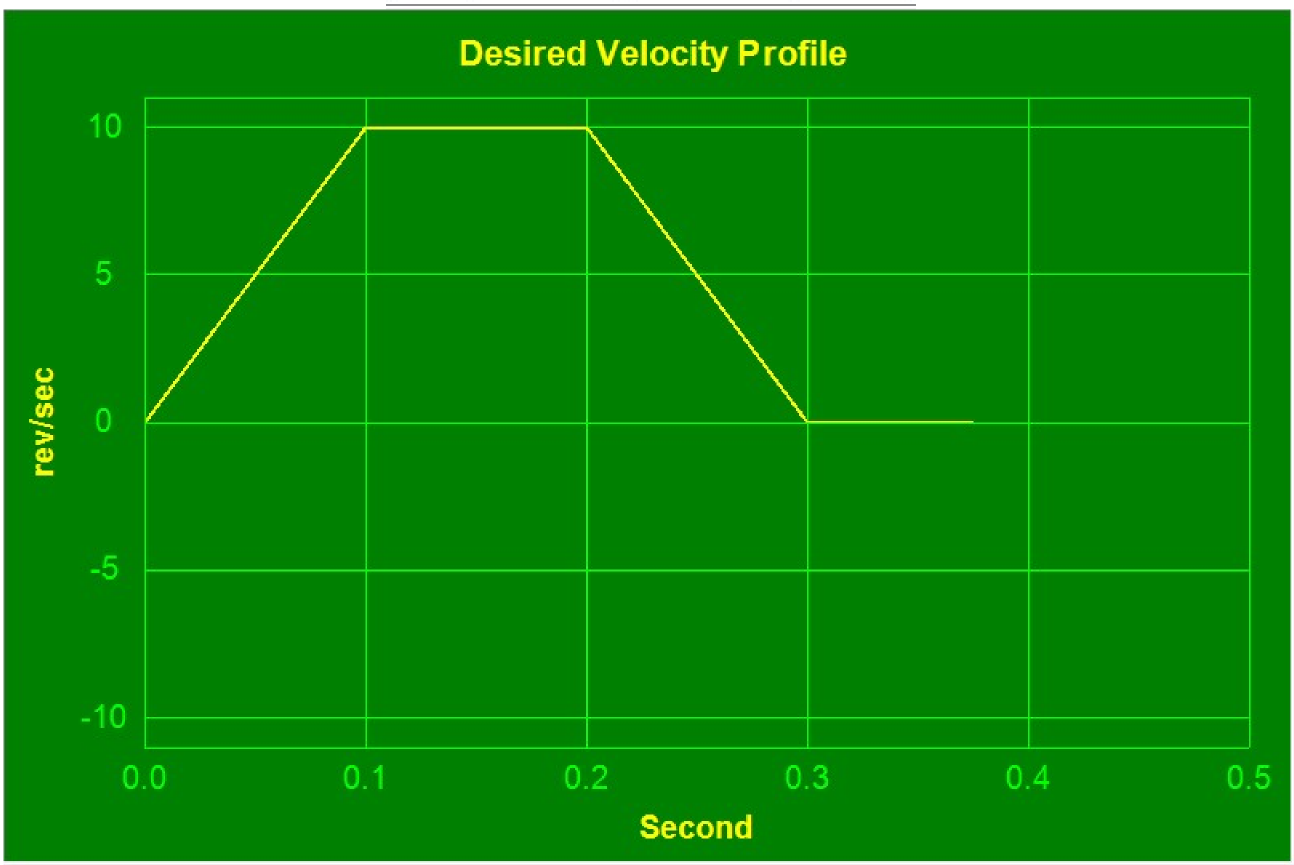
This defines the frequency span where the signal is reduced by at least 3dB. For example if the center frequency is set to 400Hz and the bandwidth to 200 the signal will be reduced by 3dB starting at 300 Hz. It will have the greatest reduction at 400Hz, and then will be greater than 3dB above 500Hz. When setting the notch filter a chart is displayed that provides an indication of the
filtering that will be accomplished.

6.2 Get Ready for Tuning

Before testing a servo-system a few more parameters need to be entered. These include the max

speed, acceleration and distance (or time) requirements of the sample move. The proper profile shape of the move is needed to operate the load in the same way as what will be expected during online operation. Accelerating the load quickly may induce significant ring into the motion profile.
Accelerating slower and going to a higher velocity can minimize the ringing. The best profile for a given move is sometimes arrived at more through experimentation than hard calculation.
Step Servo Quick Tuner provides easy entry of the profile parameters plus a display of the profile for verification.





The mechanical system should be set up as close to the final configuration as possible so that the tuning

represents what will be expected. The critical components include the coupler, mechanical interface, and similar frictional and inertial loads. As tuning can sometimes be an uncontrolled process where the mechanical system can be damaged, care must be taken to minimize this possibility. This could include having limit sensors or mechanical stops that help to prevent such damage.

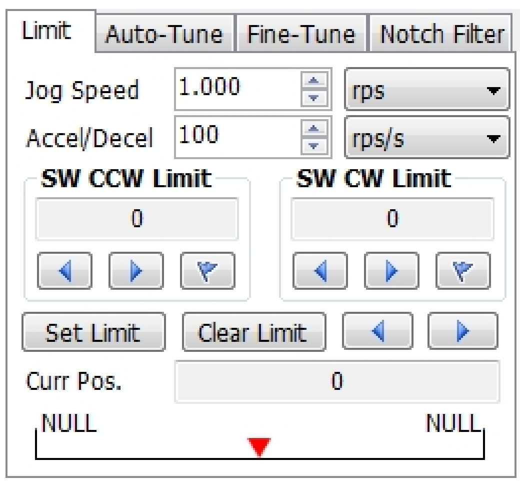
Step Servo Quick Tuner contains a sampling oscilloscope that will display of variety of measurements of an executed move. Two plots can be displayed at one time and contain the real-time information about the move performance. Before performing the test move, make sure the desired move information is selected. This can include the typical information such as **Actual Speed** or **Position Error** but also can include the **Supply Voltage** so that the power supply can be monitored for proper voltage during the move.

6.2.1 Position Limit

Before servo tuning, it is recommended to set CW and CCW position limit. *Step Servo Quick Tuner* allows you to set software position limit.

Switch the main configuration page to Tuning-Sampling page. You will see 4 tabs: Limit; Auto Tune; Fine Tune, and Notch Filter.

The soft limit setting is shown as follows;



Set JOG velocity, acceleration and deceleration values, then use the arrow and flag buttons to move to and define your soft limits:

： CCW JOG

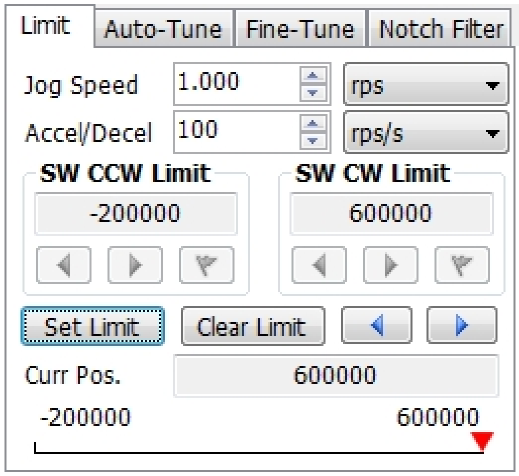
： CW JOG

： Set Current Position As Soft Limit

To set CW and CCW limit, please click and hold  to move, and click  to set limit for CW or CCW direction.

NOTE: In order to prevent accidents, please choose small JOG velocity and acceleration and deceleration value.

After both CW and CCW is set, click set limit to activate the function. As shown in below:



If new limit is required, please click on “clear limit” and the reset the required limits.

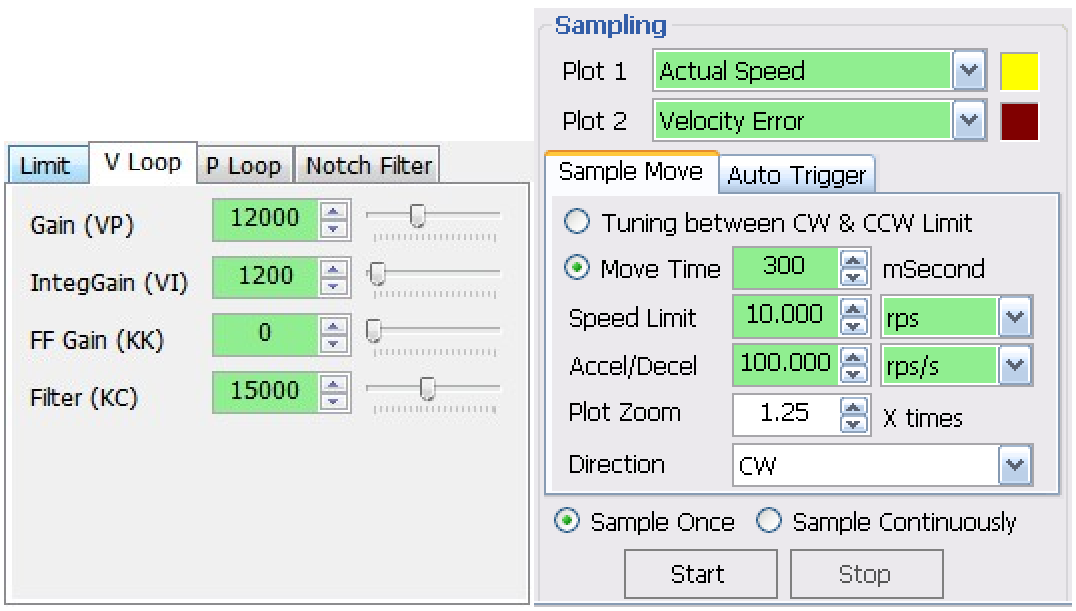
NOTE: The limit setting will NOT be saved at next power up.

6.2.2 Tuning the Velocity Loop

6.2.2.1 Entering a Sample Move

Start by selecting the **V Loop** tab. This will cause the **Sampling** to perform moves that are based on **Time** and operates the drive in the **Speed Only** Velocity mode.
Now parameters may be entered for a **Velocity** based move.

Plot 1 & Plot 2: two different values can be selected for viewing in the scope window, in this case



Actual Speed and **Velocity Error** are selected. These are typical values for Velocity tuning.
Sample Move: move profile values are entered in the **Sample Move** section. This example sets a move **Time** of 300ms at a **Jog Speed** of 10 rev/sec and an **Accel/Decel** rate of 100 rev/s/s. In the window to the right of the **Sampling** data entry section the **Desired Profile** will be displayed. This provides a visual reference of what the expected move will look like.
Plot Zoom: the length of the plot values that are displayed can be set from 1 to 5 times the profile length.
Direction: the direction of the move can be set to **cw**, **ccw** or **alternate**. These directions refer to the motor shaft as viewed from the front of the motor. **Alternate** toggles the direction after each move.

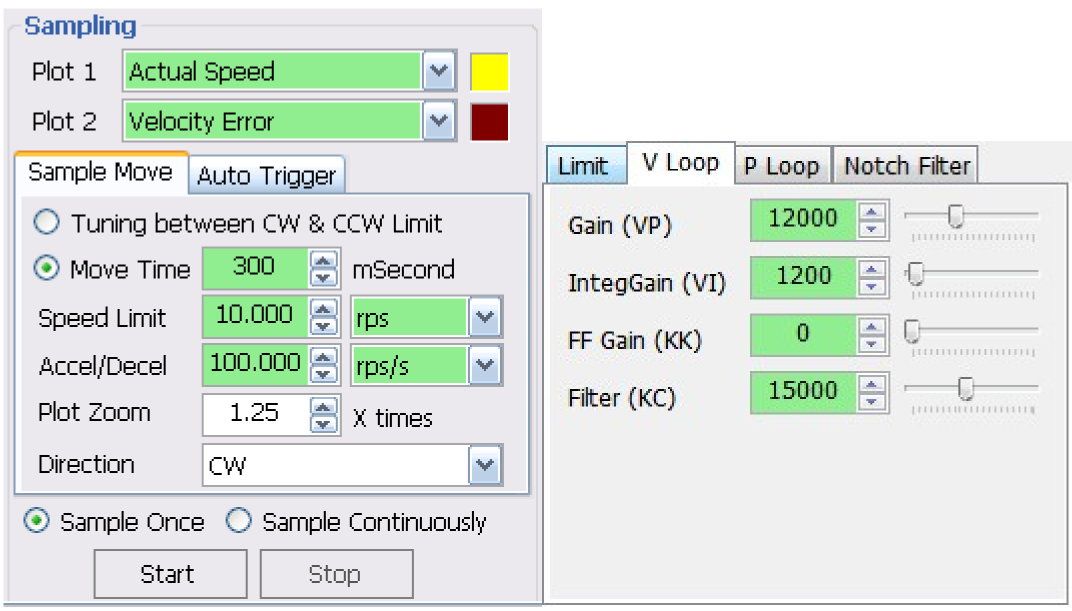
Start with a known direction before switching to toggle.

Sample Once: after the **Start** button is clicked, a single move is performed, the motor stops, and the results will be displayed.
Sample Continuously: after the **Start** button is clicked, the move will be repeated and the results displayed until the **Stop** button is clicked. During continuous sampling the tuning gains can be changed at any time and will be updated automatically. This enables more dynamic adjustment of the gains for speeding up the tuning process.

6.2.2.2 Performing a Move

Once the move settings are correct the mechanism to be moved shold also be checked to ensure it is ready to move. It is especially important to make sure the direction is set correctly. In some cases it is wise to select **alternate** to avoid running the mechanism into a hard stop. Select the **Sample Once** button. Click the **Start** button and observe the results.
If problems occurred during the move an Alarm indicating a Fault or Warning may be displayed and need to be cleared. The drive may be left disabled until the Alarm is cleared and the Enable button is clicked.
Note: Clicking the Alarm Reset button and then the Enable button will clear a fault and enable the drive.
Now the motion parameters will need to be adjusted to achieve the desired move profile. The move can be repeated by clicking the **Start** button. If the drive continues to fault it is possible the maximum current or position error parameters are being exceeded. These can be set in the **Drive Configuration** tab.

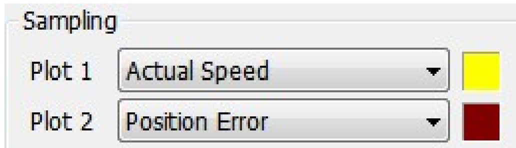
The current setting can be checked by selecting **Current** in one of the Plot lists and clicking **Start** again to see what current is being required of the drive during a move. The current profile of the move will be displayed and may give a clue as to why a fault is occurring.

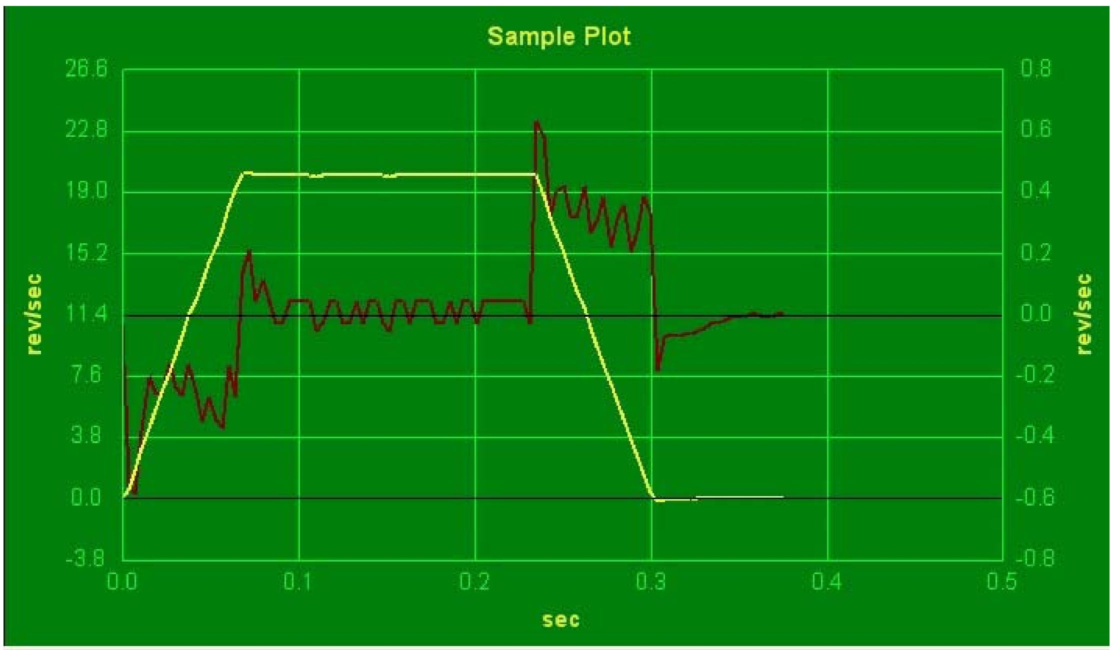


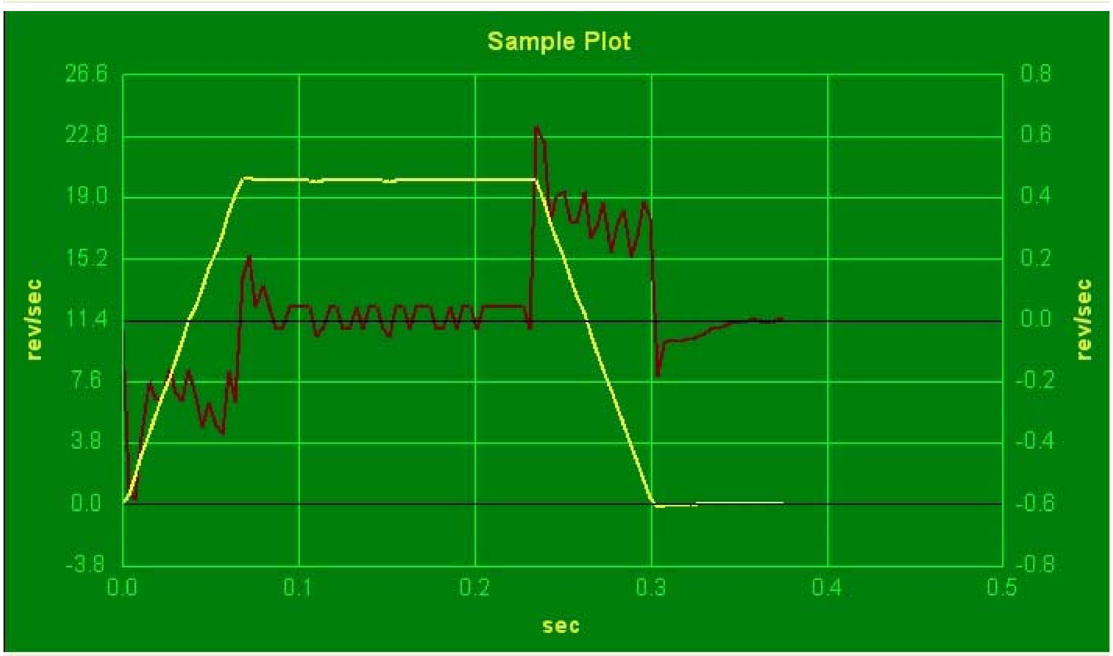
6.2.2.3 Adjusting Tuning Parameters

The two primary parameters for a Timed move are the **Proportional** (VP) & **Integral** (VI) gain parameters of the velocity loop.
Starting with these two terms is a good way to begin tuning as they are the minimum required terms in Velocity Loop tuning. The **FF Gain** is not required but adds to the tuning, this will be discussed later.
Note 1: The **Servo On** button in the Menu bar of the Step Servo Quick Tuner window under the label **Servo** will disable the motor should a serious problem occur.
Note 2: The Gain values can be changed at any time during the tuning process. When the STEP SERVO Quick Tuner software detects a change in the value it will automatically download the new value. The **Download** button in the upper right of the window does not need to be clicked.

Once a successful move has been accomplished (no fault occurs) the motor is ready for tuning. Adjust the VP and VI parameters and observe the results. VP and VI shold be adjusted at the same time and in small increments. The following two figures shows responses with different VP and VI settings.
This first plot is performed with the default tuning values and no load added to the motor.
The second plot is performed with higher gain values for the VP (25000) and VI (3000), as can be seen the velocity error decreases as the gains are increased.
To get a good comparison between different plots where the gains have been changed, turn off the **Auto Scale** by clearing that check box below the plot screen. When auto scaling is turned off, the difference can be seen more clearly.







6.2.2.4 Adding in the FF Gain (KK) parameter

The Acceleration Feed Forward (KK) applies more current to the motor to help compensate for high inertia in the system. In a servo system more current is typically required during the acceleration and deceleration phases of the move profile.

A reduction in the Velocity Error peak values should then be seen. As seen in this plot with the KK set to 3000 the peaks in the Velocity error have been reduced. With loads that have greater inertia this can provide a significant improvement.

NOTE: The FF Term (KK) is not available when operating in the Pulse & Direction Control

Mode. Setting this value will have no effect.

If the Velocity Error goes too positive during acceleration, the adjustment was too large and the value should be adjusted in smaller amounts until there is as near to zero error as possible. The

Rescale button next to the **Auto Scale** may be clicked at any time to re-scale the plot on the new

Velocity Error value.

6.2.2.5 Filter parameter

Step Servo has a control loop filter for special situations where the motor may resonate or may have significant audible noise. This filter is designed as a low pass type for the control loop output.
When a system is subject to mechanical resonance, this low pass filter can be set below the natural frequency of the system so that the control loop output does not excite the resonance.
With a large inertial load, the gain parameters, especially the VP and VI terms, may need to be set high to get a good response. The filter may then need to be decreased in value (lower frequency) to prevent ringing or oscillation. The default of 15000 works well in many cases but can be increased or decreased with little risk.

6.2.2.6 Verify the Drive Current

The amount of drive current can be verified at any time during the tuning process to make sure the current supplied to the motor is not being limited by the drive. If too much current is being required changes may be made to the move profile. Select **Current** in one of the **Plot** selection lists and repeat the move, from this the current can be evaluated.

6.2.2.7 Finishing up

If the Step Servo will only be operated in a **Velocity Control Mode** with a **Speed only** Control Type, the tuning is complete. The Position Loop **(P Loop)** does not need to be tuned as it is not used. After verifying the drive current, the **Notch Filter** may be the only setting still needing adjusting. See section on “Setting the Notch Filter”.

If the Step Servo will be operated in a **Position Control Mode,** proceed to section ”Tuning the Position Loop” below.
See Section below on “Using Auto Trigger Sampling” for tuning the Step Servo while using an external Pulse & Direction controller.

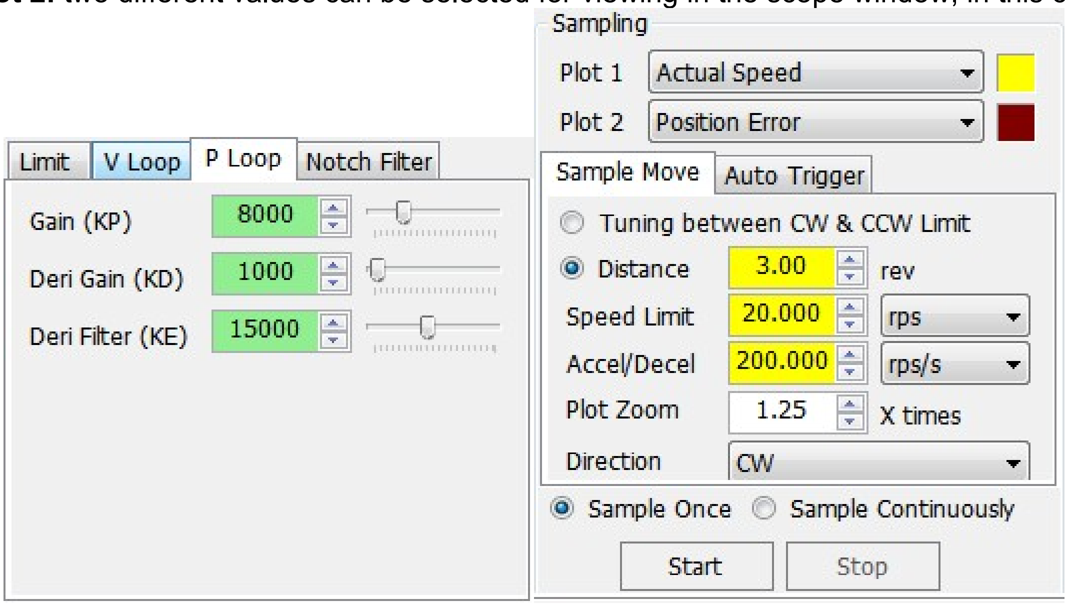
6.2.3 Tuning the Position loop

6.2.3.1 Entering a Sample Move

Select the **P Loop** tab . This will cause the **Sampling** to do moves that are based on distance and operates the drive in the **Point to Point** Positioning mode.

Now the parameters for a **Position** based move can be entered. There is one consideration that must be addressed here. If the Step Servo is being operated in the **Position Control Mode** with a **Pulse & Direction Digital Signal Type** setting and being commanded by, for example, an external Pulse and Direction controller, the **Auto Trigger** option may be used to capture and plot the move. See Section on

“Using the Auto Trigger Sampling” for more details on this feature.
Plot 1 & Plot 2: two different values can be selected for viewing in the scope window, in this case



Actual Speed and **Position Error** are selected. For Position tuning these are typical values.
Sample Move: move profile values are entered in the **Sampling** section. This example sets a move **Distance** of 3.00 revs at a **Max Speed** of 20,000 rev/sec and an **Accel/Decel** rate of 200 rev/s/s. In the window to the right of the **Sampling** data entry section the **Desired Profile** will be displayed. This provides a visual reference of what the expected move will look like.
Plot Zoom: the length of the plot values that are displayed can be set from 1 to 5 times the profile length.
Direction: the direction of the move can be set to **cw**, **ccw** or **alternate**. These directions refer to the motor shaft as viewed from the front of the motor. **Alternate** toggles the direction after each move.
Start with a known direction before switching to toggle.

Sample Once: after the **Start** button is clicked, a single move is performed, the motor stops, and the results will be displayed.
Sample Continuously: after the **Start** button is clicked, the move will be repeated and the results displayed until the **Stop** button is clicked. During continuous sampling the tuning gains can be changed at any time and will be updated automatically. This enables more dynamic adjustment of the gains for speeding up the tuning process.

6.2.3.2 Performing a Move

Once the move settings are correct the mechanism to be moved shold also be checked to ensure it is ready to move. It is especially important to make sure the direction is set correctly. In some cases it is wise to select **alternate** to avoid running the mechanism into a hard stop. Select the **Sample Once** button. Click the **Start** button and observe the results.
If problems occurred during the move an Alarm indicating a Fault or Warning may be displayed and need to be cleared. The drive may be left disabled until the Alarm is cleared and the Enable button is clicked.
Note: Clicking the Alarm Reset button and then the Enable button will clear a fault and enable the drive.
Now the motion parameters will need to be adjusted to achieve the desired move profile. The move can be repeated by clicking the **Start** button. If the drive continues to fault it is possible the maximum current or position error parameters are being exceeded.
These can be set in the **Drive Configuration** tab.
The current setting can be checked by selecting **Current** in one of the Plot lists and clicking **Start** again to see what current is being required of the drive during a move. The current profile of the move will be displayed and may give a clue as to why a fault is occurring.

6.2.3.3 Adjusting the Gain (KP) and Deri. Gain (KD) parameters

Adjust the KP and KD parameters and observe the results. Increasing the KP may improve the positioning performance, but it may also cause the system to be more unstable. To counter this the KD can be increased. The KD parameter is important: too little gain will cause the system to oscillate; too much gain may cause the system to squeal from a high frequency oscillation. If a very springy coupler is used between the motor and load, the KD parameter may need to be reduced until the system is stable or the **Notch Filter** may need to be used to reduce the system gain at the sensitive frequency where it oscillates.

6.2.3.4 The Deri Filter (KE) parameter

With a large inertial load, the KP and KD gain parameters may need to be set high to get good response. The filter may then need to be decreased in value (lower frequency) to prevent ringing or decrease the derivative noise.

6.2.3.5 Filter parameter (again)

Sometimes it may also be necessary to adjust the output filter when gain values increase. The filter frequency may then need to be decreased in value to prevent ringing or oscillation.

6.2.3.6 Verify the Drive Current

The amount of drive current can be verified at any time during the tuning process to make sure the current supplied to the motor is not being limited by the drive. If too much current is being required changes may be made to the move profile. Select **Current** in one of the **Plot** selection lists and repeat the move, from this the current can be evaluated.

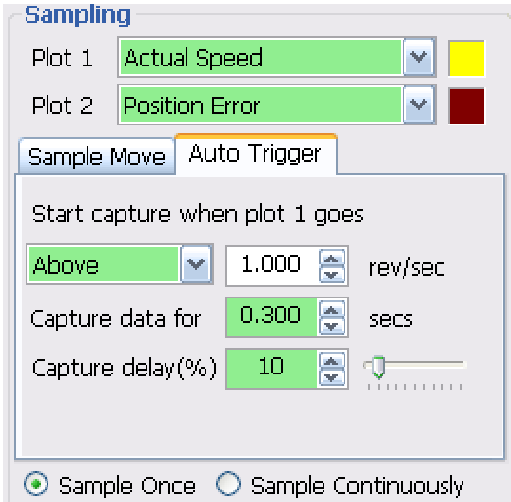
6.2.3.7 Finishing up

After verifying the drive current, the **Notch Filter** may be the only setting still needing adjusting.
See section on “Setting the Notch Filter”.

6.2.4 Using Auto Trigger Sampling

In cases where an external controller is used to perform move profiles, such as in the **Position Control Mode** using **Pulse & Direction** input, the **Auto Trigger** will allow the **Sampling** to collect data and display the move profile.
This sampling technique is different in that it is not triggered by the start of a move profile as the drive cannot know when the move is actually started (remember the controller is external). Instead the **Auto Trigger** waits for a predefined set of conditions to tell it when to start collecting the move profile data.

When using **Auto Trigger**, the primary effort is to select the conditions that will trigger the sampling. Begin by selecting the desired trigger value in the **Plot 1** list. This selection is what is monitored by the Auto Trigger, **Plot 2** is not monitored.



In the Auto Trigger tab the displayed text will indicate the value to be used and the conditions to trigger the capture of the selected value. In the example to the right, the capture will begin when **Actual Speed** is **Above 1.000 rev/sec**, the capture will **Capture data** for **0.300 seconds** and there will be a **10% Capture delay** from the beginning of the capture to the trigger point. The **Capture delay** allows viewing of the data prior to the trigger point so that a more complete profile can be observed.

When changing **Plot 1** to other selections notice that the conditions for the capture trigger will change with it. For example, when selecting **Position Error** the capture will look at **Counts** for determining the trigger point.

Sample Once: when the **Start** button is clicked the Step Servo drive begins continuous collection of data. It will constantly check the data to see if the value meets the capture trigger conditions. At the same time Quick Tuner monitors the status of the Step Servo to detect if the capture is complete.

When the capture is complete the data is displayed in the profile window.

Sample Continuously: when the **Start** button is clicked the capture is repeated each time the trigger condition is met until the **Stop** button is clicked. During continuous sampling the tuning gains can be changed at any time and will be updated automatically. This allows more dynamic adjustment of the gains for speeding up the tuning process

NOTE: When adjusting control loop gain values remember that the FF Term (KK) has no effect when operating in the Position – Pulse & Direction Control Mode.

7 Step 3: Q Programming

The Q programming language allows you to create motion control programs and store them in your step servo drive's built-in, non-volatile memory. A Q program can be set to run automatically when the drive

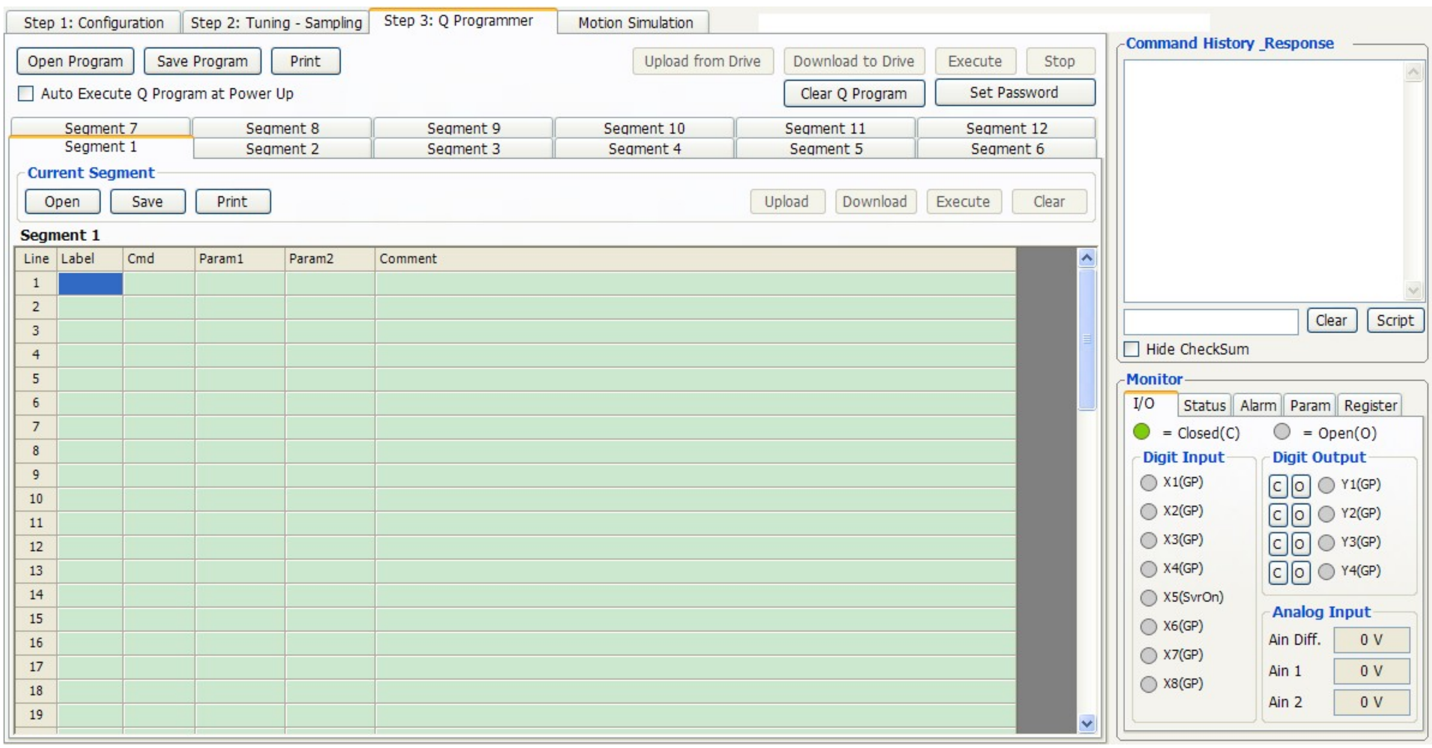
powers up, or to wait for a “go” command from a host PC, PLC, HMI or other device. Q programs are useful in creating standalone motion control devices and for creating customized, distributed control nodes for a RS-485, Modbus, EtherNet/IP and CANopen networks.

Q programs have access to all of the drive’s control modes and move types. Other capabilities include multitasking, looping, conditional processing, subroutines, fault handling, math calculations and data register manipulation.

A single Q program can have 12 individual segments, each segment can have maximum 62 lines of command.

7.1 Q Programmer Page

The Q programmer page is used for creating Q programs to be stored on and executed by your step servo drive. At the top of the page are nine command buttons.



Open Q program: Open Q program file from your computer disk
Save Q program: Save Q program file to your computer disk
Print: Print current Q program
Upload from Drive: Upload Q program from the drive.
Download to Drive: Download current Q program to the drive.
Clear Q Program: Clear current Q program.
Execute: Execute current Q program.
Stop: Stop the current running Q program
Set Password: Set Q program password. This locks your Q program to prevent unauthorized persons from uploading it from your drive. If you forget your password, you can enter the default password “1234” to unlock it, but it will also erase the stored Q program.

Auto Execute Q program at power up: checking this box instructs the drive to automatically execute segment 1 of the Q program at power up.

7.2 Current Segment

There are up to 12 segments within a Q program. Click on each segment's tab to edit it. Each tab has its own set of command buttons that pertain only to that segment.

Open Q segment: Open Q segment file from your computer disk
Save Q segment: Save Q segment file from your computer disk

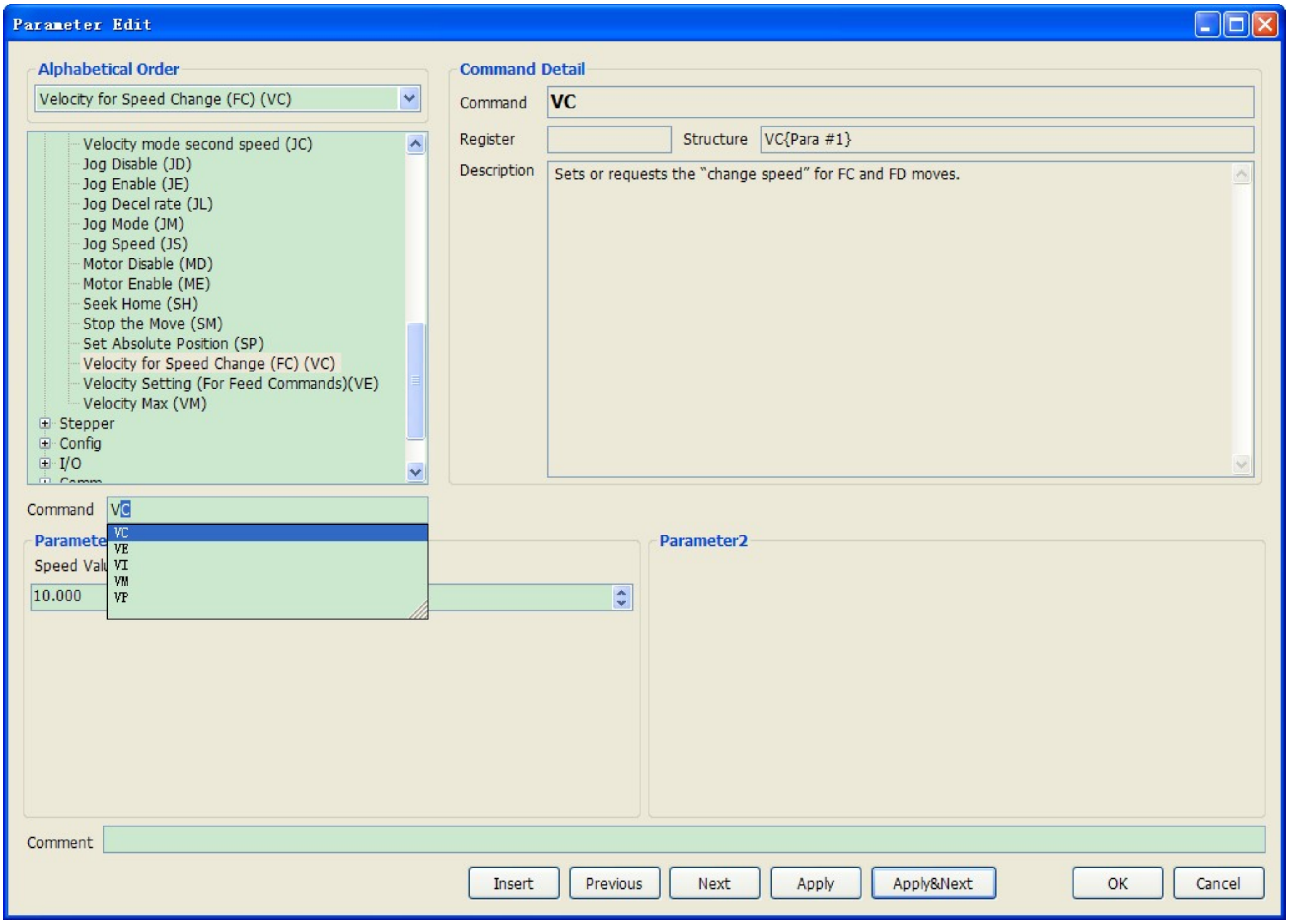
Print: Print current Q segment
Upload from Drive: Upload Q segment from the drive.

Download from Drive: Download Q segment from the drive.

Execute: Execute current Q segment.
Stop: Stop current Q segment.

7.3 Command Editing

If you click any box in the Cmd column, and then click on the button, the Command editing page will pop up as follows:



The Command list is on the left hand side of the window. In addition, you can also search for commands by alphabetical order by opening the list above the tree, or type the command name directly into the "command" box on the right.

If the command is found, the command details will be shown on the right hand side of the window.

Command values can be entered via the parameter 1 and parameter 2 boxes if needed by the command.

The Comment field allows you to describe this line of your Q program.

Insert: Insert a blank line within the current Q segment.

Previous: Moving up by one line within the current Q segment.

Next: Moving down by one line within the current Q segment.

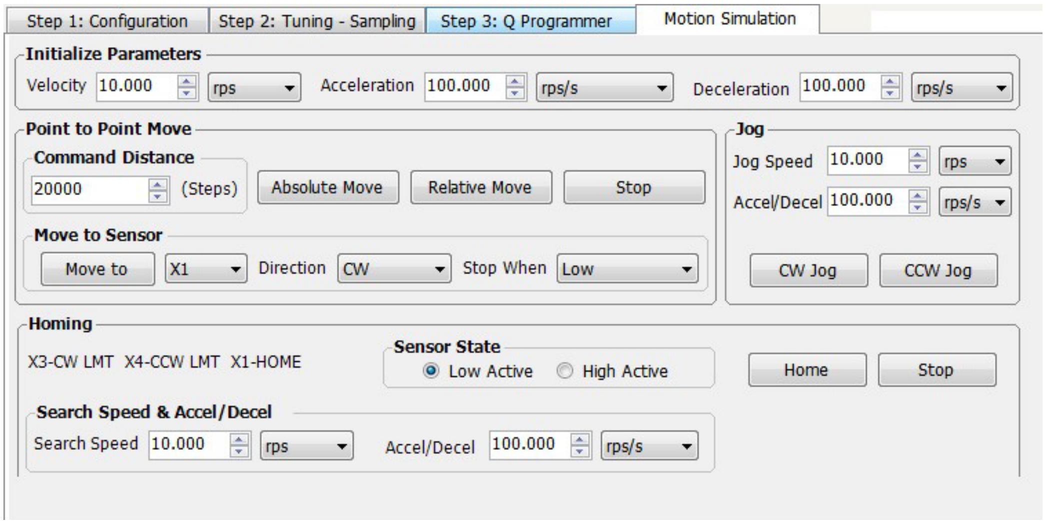
Apply: Apply current command to the segment

Apply and Next: Apply current command and move to the next line.

Ok: Apply current command to the segment and quit.

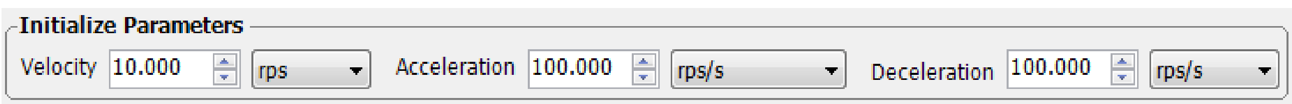
Cancel: Quit the command editing window without save the change.

8 Motion Simulation



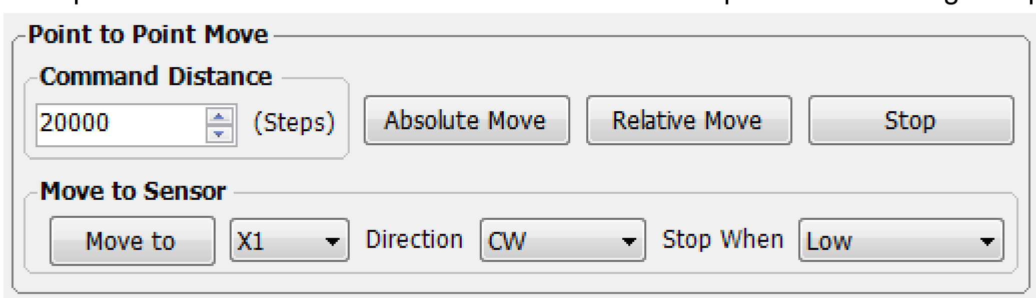
8.1 Initialize Parameters

In this frame you'll want to set the speed, acceleration and deceleration to be used by the Point to Point Move frame.



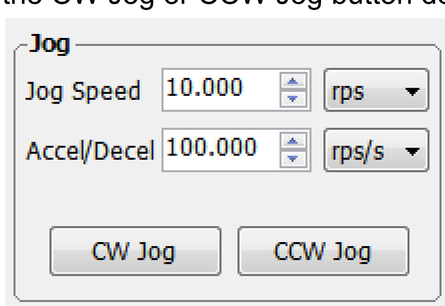
8.2 Point to Point Move

The Point to Point Move frame allows you to set a move distance, and then command a move to relative position, absolute position or to a sensor connected to one of the step servo drive's digital inputs.



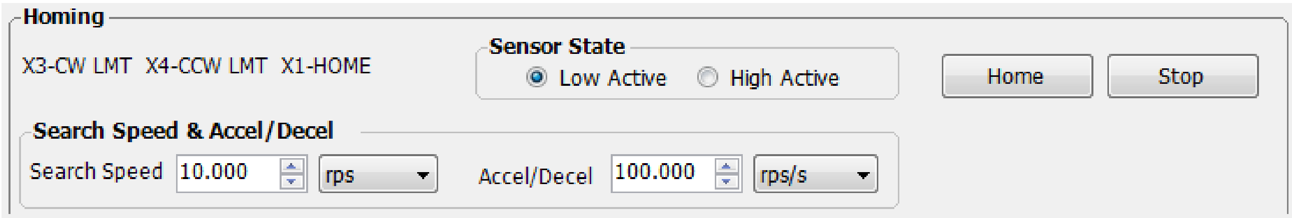
8.3 Jog

The Jog frame allows you set the jog speed and jog acceleration/deceleration, then move the motor at a constant speed on command. Hold the CW Jog or CCW Jog button down to start and release to stop.



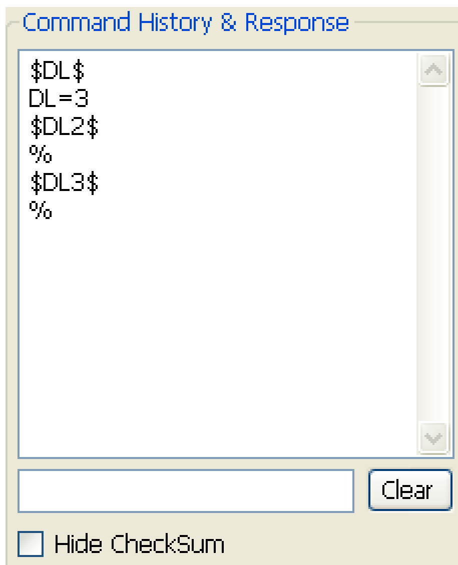
8.4 Homing

Homing allows you set a sensor state, search speed and acceleration/deceleration. Click "Start" and the motor will find the home sensor, bouncing off end of travel limits if necessary to find it. You can click the "Stop" button to interrupt when homing.

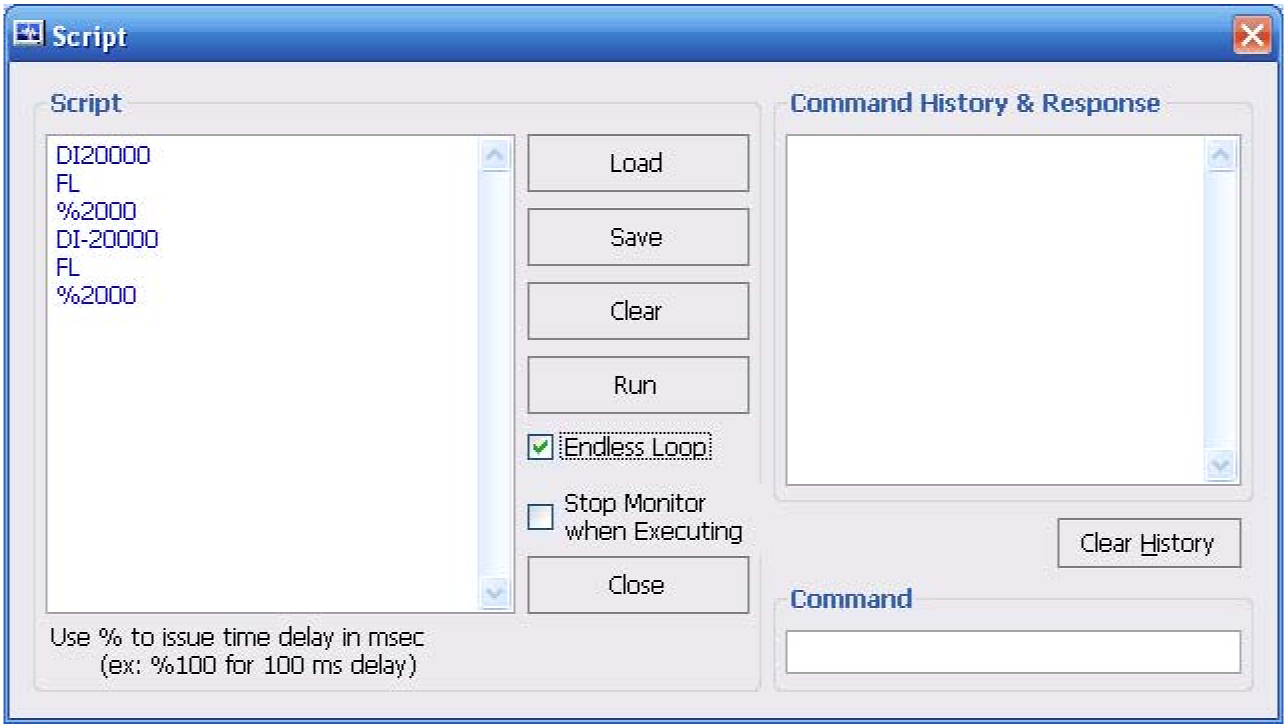


9 SCL Terminal

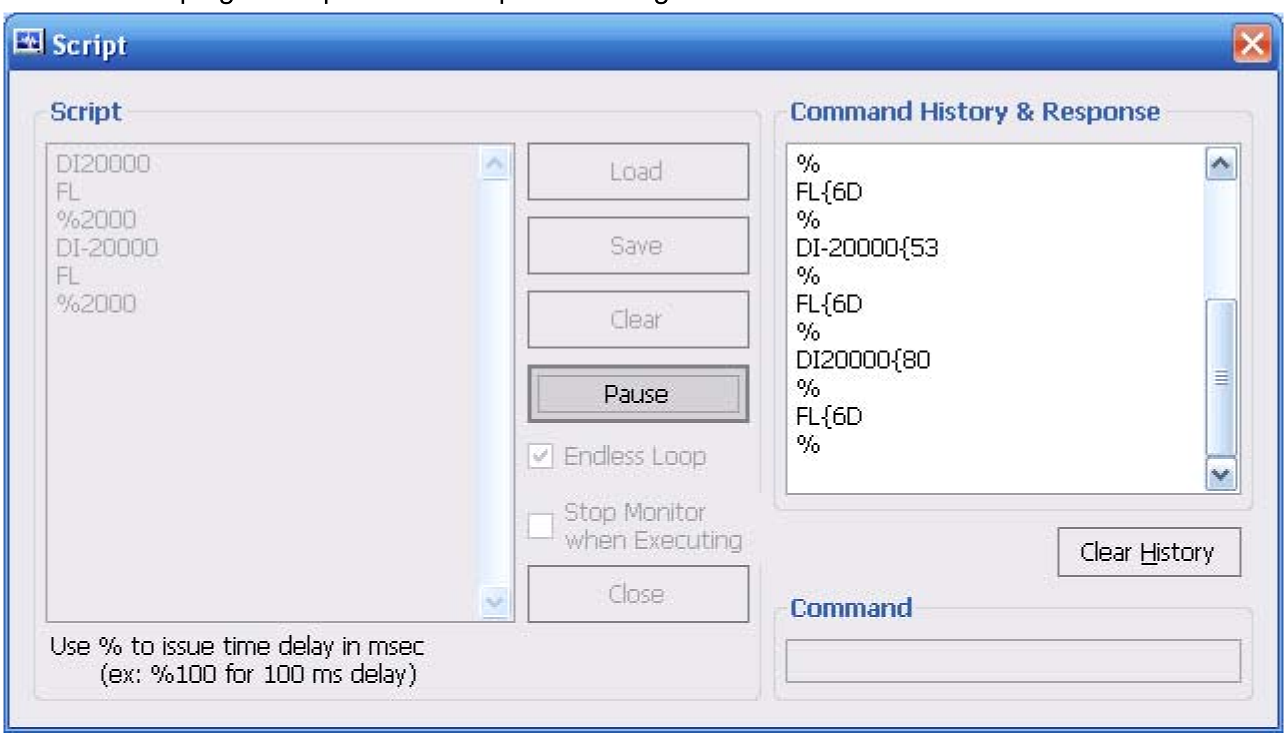
The SCL Terminal allows you to send SCL commands to the drive, regardless of the operating mode. The terminal is also useful as a commissioning tool, allowing you to test your drive and SCL without having to launch a separate application.



In SCL terminal window, there is a “Script” button, click on the button, the Script window shows up. See below.



Edit a SCL command script and check “Endless Loop” box, click Run will perform to run SCL commands in looping. Click pause will stop the running.

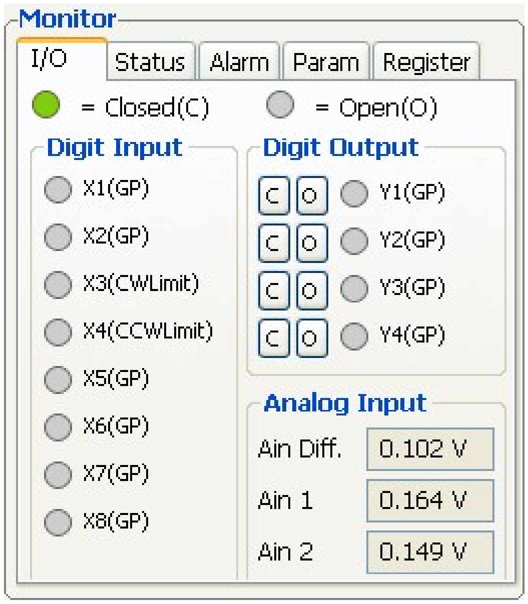


Note if you check box on “Stop Monitor when Executing”, the software will stop background status monitoring. This will make the script run more efficiently.

10 Status Monitor

The Status Monitor can display I/O status, Drive status, Alarms, Parameters and Registers.

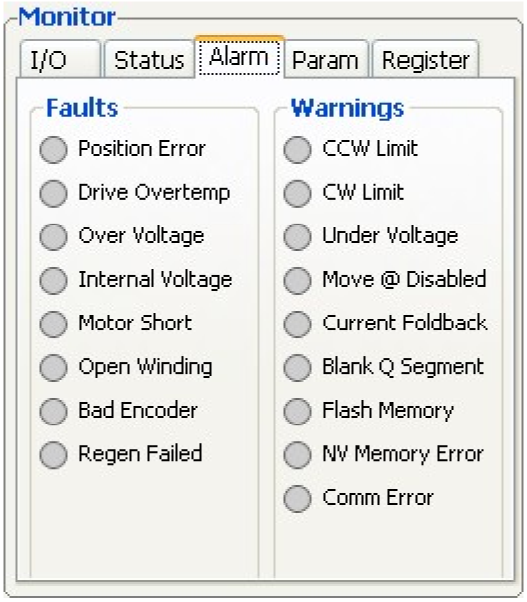
10.1 I/O Monitor



It shows the Digital Input status, measures the analog input value and be able to control the digital output status.

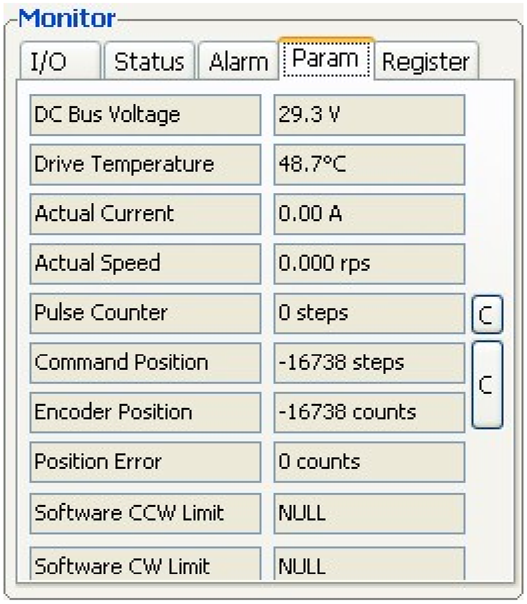
10.2 Drive Status Monitor

10.3 Alarm Monitor

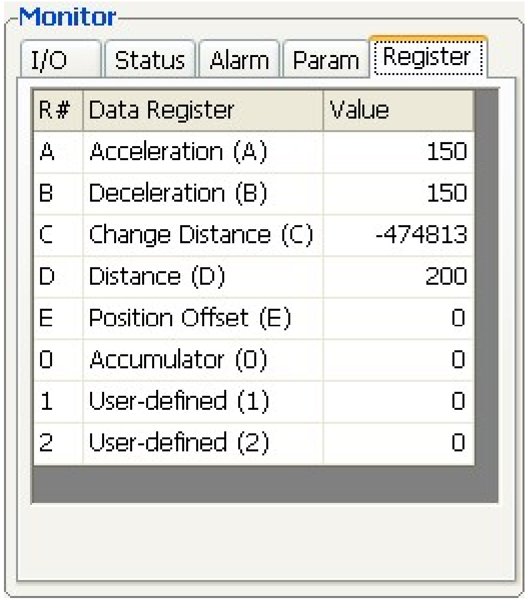


There are two categories of alarm, faults and warnings.
A faults alarm will be indicated in red color flag.
A warning alarm will be indicated in yellow color flag.

10.4 Drive Parameter Monitor



10.5 Register Monitor



11 Appendix A: SCL Reference

SCL or Serial Command Language, was developed to give users a simple way to control a motor drive via a serial port. This eliminates the need for separate motion controllers to supply control signals, like Pulse & Direction or +/-10V signals, to step and servo motor drives. It also provides an easy way to interface to a variety of other industrial devices like PLCs and HMIs, which most often have standard or optional serial ports for communicating to other devices.

NOTE: For more details about SCL command, please download the latest Host Command Reference manual from our website www.applied-motion.com. Check back periodically for updates as this document may be changed without notification to the customers.

11.1 Commands

There are two types of host commands available: buffered and immediate. Buffered commands are loaded into and executed out of the drive's volatile command buffer, also known as the *queue*. Immediate commands are not buffered: when received by the drive, they are executed immediately.

11.1.1 Buffered Commands

After being loaded into the command buffer of a drive, buffered commands are executed one at a time. (See "Multi-tasking in Q Drives" below for an exception to this rule). If you send two buffered commands to the drive in succession, like an FL (Feed to Length) command followed by an SS (Send String) command, the SS command sits in the command buffer and waits to execute until the FL command is completed. The command buffer can be filled up with commands for sequential execution without the host controller needing to wait for a specific command to execute before sending the next command. Special buffer commands, like PS (Pause) and CT (Continue), enable the buffer to be loaded and to pause execution until the desired time.

Stored Programs in Q Drives

Stored Q Programs, created with the *Q Programmer* application software, are created by using only buffered commands.

Multi-tasking in Q Drives

Multi-tasking allows for an exception to the “one at a time” rule of buffered commands. The multi-tasking feature of a Q drive allows you to initiate a move command (FL, FP, CJ, FS, etc.) and proceed to execute other commands without waiting for the move command to finish.

11.1.2 Immediate Commands

Immediate commands are executed right away, running in parallel with a buffered command if necessary. For example, this allows you to check the remaining space in the buffer using the BS (Buffer Status) command, or the immediate status of digital inputs using the IS (Input Status) command, while the drive is processing other commands. Immediate commands are designed to access the drive at any time.

Applied Motion Products recommends waiting for an appropriate Ack/Nack response from the drive before sending subsequent commands. This adds limited overhead but ensures that the drive has received and executed the current command, preventing many common communication errors. If the Ack/Nack functionality cannot be used in the application for any reason, the user should allow a 10ms delay between commands to allow the drive sufficient time to receive and act on the last command sent.

This approach allows a host controller to get information from the drive at a high rate, most often for checking drive status or motor position.

11.2 Using Commands

The basic structure of a command packet from the host to the drive is always a text string followed by a carriage return (no line feed required). The text string is always composed of the command itself, followed by any parameters used by the command. The carriage return denotes the end of transmission to the drive. Here is the basic syntax.

YXXAB<cr>

In the syntax above, “Y” symbolizes the drive’s RS-485 address, and is only required when using RS-

485 networking. “XX” symbolizes the command itself, which is always composed of two capital letters. “A” symbolizes the first of two possible parameters, and “B” symbolizes the second. Parameters 1 and 2 vary in length, can be letters or numbers, and are often optional. The “<cr>” symbolizes the carriage return which terminates the command string. How the carriage return is generated in your application will depend on your host software.

Once a drive receives the <cr> it will determine whether or not it understood the preceding characters as a valid command. If it did understand the command the drive will either execute or buffer the command. If Ack/ Nack is turned on (see PR command), the drive will also send an Acknowledge character (Ack) back to the host. The Ack for an executed command is % (percent sign), and for a buffered command is * (asterisk).

It is always recommended that the user program wait for an ACK/NACK character before subsequent commands are sent. If the ACK/NACK functionality cannot be used in the application, a 10ms delay is recommended between non-motion commands.

If the drive did not understand the command it will do nothing. If Ack/Nack is turned on a Nack will be sent, which is signified by a ? (question mark). The Nack is usually accompanied by a numerical code that indicates a particular error. To see a list of these errors see the PR command details in the Appendix of the Host Command Reference.

Responses from the drive will be sent with a similar syntax to the associated SCL command.

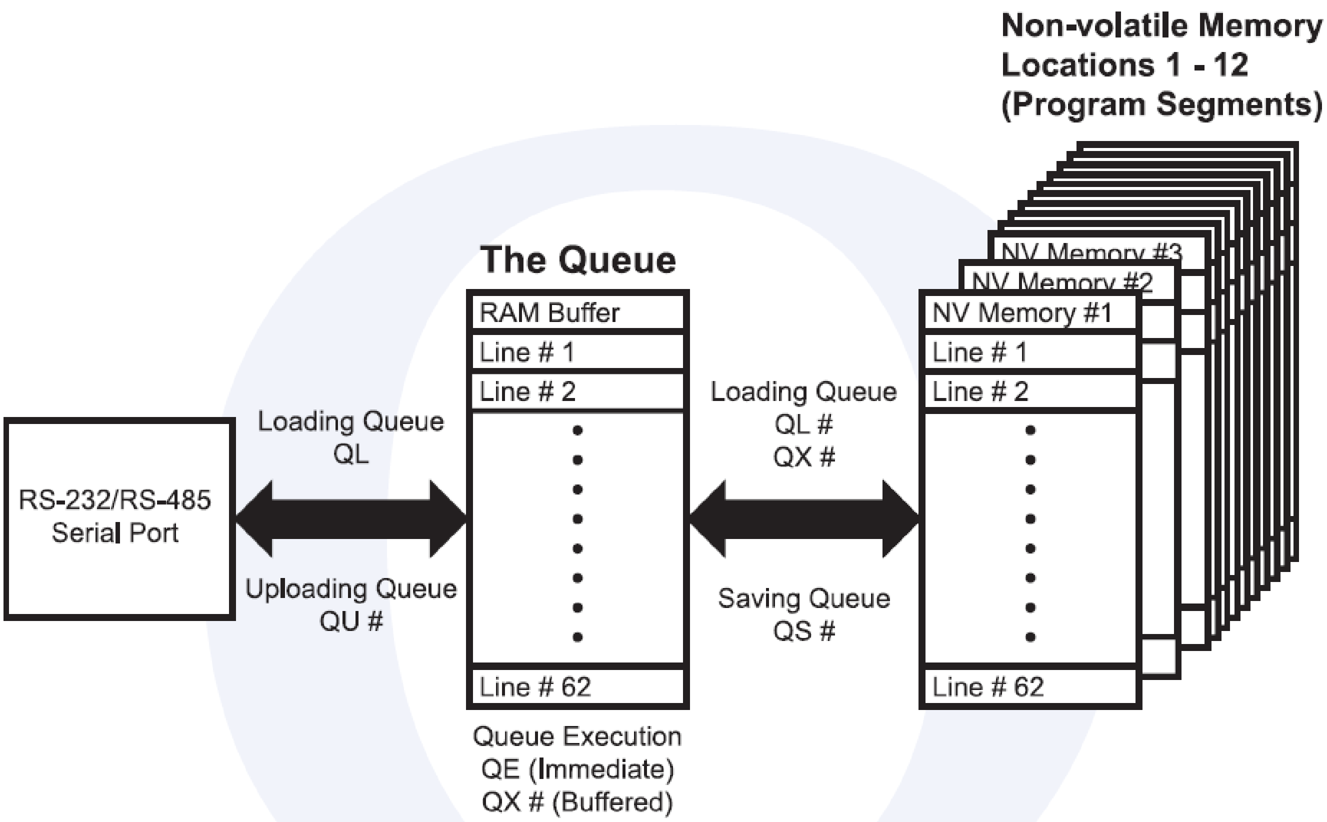
YXX=A<cr>

In the syntax above, “Y” symbolizes the drive’s RS-485 address, and is only present when using RS-485 networking. “XX” symbolizes the command itself, which is always composed of two capital letters. “A” symbolizes the requested data, and may be presented in either Decimal or Hexadecimal format (see the IF command). The “<cr>” symbolizes the carriage return which terminates the response string.

11.2.1 Commands in Q drives

Q drives have additional functionality in that commands can also be composed into a stored program that the Q drive can run stand-alone. The syntax for commands stored in a Q program is the same as if the commands were being sent directly from the host, or “XXAB”. Q Programmer software is used to create stored Q programs and can be downloaded for free from www.applied-motion.com.

The diagram below shows how commands sent from the host’s serial port interact with the volatile command buffer (AKA the Queue), and the drive’s non-volatile program memory storage. Loading and Uploading the Queue contents via the serial port are done with the QL and QU commands, respectively. Similarly, the Queue’s contents can be loaded from NV memory using the QL and QX commands, and can be saved to NV memory with the QS command. Finally, commands currently in the Queue can be executed with the QE or QX command.



The *Q Programmer* software automates many of the functions shown in the diagram above.

11.2.2 SCL Utility software

The SCL Utility software is an excellent application for familiarizing yourself with host commands. SCL Utility can be downloaded for free from www.applied-motion.com

To send commands to your drive from SCL Utility simply type a command in the Command Line and press the ENTER key to send it. (Remember that all commands are capital letters so pressing the Caps Lock key first is a good tip). Pressing the ENTER key while in SCL Utility does two things: it terminates the command with a carriage return and automatically sends the entire string. Try the example sequence below. In this example, note that <ENTER> means press the ENTER key on your keyboard, which is the same as terminating the command with a carriage return.

IMPORTANT: We recommend practicing with SCL commands with no load attached to the motor shaft. You want the motor shaft to spin freely during startup to avoid damaging mechanical components in your system.

AC25<ENTER>	Set accel rate to 25 rev/sec/sec.
DE25<ENTER>	Set decel rate to 25 rev/sec/sec
VE5<ENTER>	Set velocity to 5 rev/sec
FL20000<ENTER>	Move the motor 20000 steps in the CW direction.

If your motor didn't move after sending the FL20000 check the LEDs on your drive to see if there is an error present. If so send the AR command (AR<ENTER>) to clear the alarm. If after clearing the alarm you see a solid green LED it means the drive is disabled. Enable the drive by sending the ME command (ME<ENTER>) and verify that the you see a steady, flashing green LED. Then try the above sequence again.

Here is another sample sequence you can try.

JA10<ENTER>	Set jog accel rate to 10 rev/sec/sec
JL10<ENTER>	Set jog decel rate to 10 rev/sec/sec
JS1<ENTER>	Set jog speed to 1 rev/sec
CJ<ENTER>	Commence jogging
CS-1<ENTER>	Change jog speed to 1 rev/sec in CCW direction
SJ<ENTER>	Stop jogging

In the above sequence notice that the motor ramps to the new speed set by CS. This ramp is affected by the JA and JL commands. Try the same sequence above with different JA, JL, JS, and CS values to see how the motion of the motor shaft is affected.

11.3 Command Summary

This section contains a set of tables that list all of the Host Commands available with drives that accept streaming commands. In each table there are a number of columns that give information about each command.

- “Command” shows the command’s two-letter Command Code.
- “Description” shows the name of each command.
- “NV” designates which commands are Non-volatile: that is, which commands are saved in non-volatile memory when the SA (Save) command is sent to the drive. Note that certain commands (PA, PB, PC, PI, and PM) save their parameter data to non-volatile memory immediately upon execution, and need not be followed by an SA command.
- “Write only” or “Read only” is checked when a command is not both Read/Write compatible.
- “Immediate” designates an immediate command (all other commands are buffered).
- “Compatibility” shows which drives use each of the commands.

The different categories for these tables - Motion, Servo, Configuration, I/O, Communications, Q Program, Register - are set up to aid you in finding particular commands quickly.

- “Motion” commands have to do with the actual shaft rotation of the step or servo motor.
- “Servo” commands cover servo tuning parameters, enabling / disabling the motor, and filter setup.
- “Configuration” commands pertain to setting up the drive and motor for your application, including tuning parameters for your servo drive, step resolution and anti-resonance parameters for your step motor drive, etc.
- “I/O” commands are used to control and configure the inputs and outputs of the drive.
- “Communications” commands have to do with the configuration of the drive’s serial ports.
- “Q Program” commands deal with programming functions when creating stored programs for Q-programmable drives.
- “Register” commands deal with data registers. Many of these commands are only compatible with Q-programmable drives.

11.3.1 Motion Commands

Command	Description	NV	write only	read only	Immediate	Compatibility
AC	Accel Rate	•				All drives
AM	Accel Max	•				All drives
CJ	Commence Jogging		•			All drives
DC	Distance for FC, FM, FO, FY	•				All drives
DE	Decel Rate	•				All drives
DI	Distance or Position	•				All drives
ED	Encoder Direction	•				Servos and steppers with encoder feedback
EF	Encoder Function	•				Servos and steppers with encoder feedback
EG	Electronic Gearing	•				All drives
EH	Extended Homing		•			All Step Servo drives and M2 Servo drives
EI	Input Noise Filter	•				All drives
EP	Encoder Position					Servos and steppers with encoder feedback
FC	Feed to Length with Speed Change		•			All drives
FD	Feed to Double Sensor		•			All drives
FE	Follow Encoder		•			All drives
FH	Find Home		•			All Step Servo drives and M2 Servo drives
FL	Feed to Length		•			All drives
FM	Feed to Sensor with Mask Dist		•			All drives
FO	Feed to Length & Set Output		•			All drives
FP	Feed to Position		•			All drives
FS	Feed to Sensor		•			All drives
FY	Feed to Sensor with Safety Dist		•			All drives
HA	Homing Acceleration	•				All Step Servo drives and M2 Servo drives
HC	Hard Stop Current	•				All Step Servo drives
HL	Homing Deceleration	•				All Step Servo drives and M2 Servo drives
HO	Homing Offset	•				All Step Servo drives and M2 Servo drives
HS	Hard Stop Homing		•			All Step Servo drives
HV	Homing Velocity	•				All Step Servo drives and M2 Servo drives
HW	Hand Wheel		•			All drives
JA	Jog Accel/Decel rate	•				All drives
JC	Velocity mode second speed	•				All drives
JD	Jog Disable		•			All drives
JE	Jog Enable		•			All drives

JL	Jog Decel rate	·				All drives
JM	Jog Mode	·				Al drives (see JM command)
JS	Jog Speed	·				All drives
MD	Motor Disable		·			All drives
ME	Motor Enable		·			All drives
MR	Microstep Resolution	·				Stepper drives only
PA	Power-up Accel Current	·				STM stepper drives only
SD	Set Direction	·				STM stepper drives with Flex I/O only
SH	Seek Home		·			All drives
SJ	Stop Jogging		·		·	All drives
SM	Stop the Move		·			Q drives only
SP	Set Absolute Position					All drives
ST	Stop Motion		·		·	All drives
VC	Velocity for Speed Change (FC)	·				All drives
VE	Velocity Setting (For Feed Commands)	·				All drives
VM	Velocity Max	·				All drives
WM	Wait on Move		·			Q drives only
WP	Wait on Position		·			Q drives only

11.3.2 Servo Commands

Command	Description	NV	write only	read only	Immediate	Compatibility
CN	Second Control Mode	·				M2 servo drives only
CO	Node ID/ IP Address Series Number	·				M2 servo drives only
CP	Change Peak Current	·				Servo drives only
DD	Default Display Item of LEDs	·				M2 servo drives only
DS	Switching Electronic Gearing	·				M2 servo drives only
EN	Numerator of Electronic Gearing Ratio	·				M2 servo drives only
EP	Encoder Position					Servo drives only
EU	Denominator of Electronic Gearing Ratio	·				M2 servo drives only
FA	Function of the Single-ended Analog Input	·				M2 servo drives only
GC	Current Command	·			·	Servo drives only
GG	Controller Global Gain Selection	·				M2 servo drives only
IC	Immediate Current Command			·	·	Servo drives only
IE	Immediate Encoder Position			·	·	Servo drives only
IQ	Immediate Actual Current			·	·	Servo drives only
IX	Immediate Position Error			·	·	Servo drives only
JC	Eight Jog Velocities	·				M2 servo drives only
KC	Overall Servo Filter	·				Servo drives only
KD	Differential Constant	·				Servo drives only
KE	Differential Filter	·				Servo drives only

KF	Velocity Feedforward Constant	•				Servo drives only
KI	Integrator Constant	•				Servo drives only
KJ	Jerk Filter Frequency	•				SV7 Servo drives only
KK	Inertia Feedforward Constant	•				Servo drives only
KP	Proportional Constant	•				Servo drives only
KV	Velocity Feedback Constant	•				Servo drives only
MS	Control Mode Selection	•				M2 servo drives only
PF	Position Fault	•				Servo drives, drives with encoder feedback
PH	Inhibition of the pulse command	•				M2 servo drives only
PK	Parameter Lock	•				M2 servo drives only
PL	Position Limit	•				Servo drives only
PP	Power-Up Peak Current	•				Servo drives only
PV	Second Electronic Gearing	•				M2 servo drives only
TV	Torque Ripple	•				M2 servo drives only
VI	Velocity Integrator Constant	•				Servo drives only
VP	Velocity Mode Proportional Constant	•				Servo drives only
VR	Velocity Ripple	•				M2 servo drives only

11.3.3 Configuration Commands

Command	Description	NV	write only	read only	Immediate	Compatibility
AL	Alarm Code			•	•	All drives
AR	Alarm Reset		•		•	All drives
BD	Brake Disengage Delay time	•				All drives
BE	Brake Engage Delay time	•				All drives
BS	Buffer Status			•	•	All drives
CA	Change Acceleration Current	•				STM stepper drives only
CC	Change Current	•				All drives
CD	Idle Current Delay	•				Stepper drives only
CF	Anti-resonance Filter Frequency	•				Stepper drives only
CG	Anti-resonance Filter Gain	•				Stepper drives only
CI	Change Idle Current	•				Stepper drives only
CM	Control mode	•				All drives
CP	Change peak current	•				Servo drives only
DA	Define Address	•				All drives
DL	Define Limits	•				All drives
DP	Dumping Power	•				SS drives only
DR	Data Register for Capture		•			Q servo drives only
ED	Encoder Direction	•				Servo drives, drives with encoder feedback
ER	Encoder or Resolution	•				Servo drives, drives with encoder feedback
HG	4th Harmonic Filter Gain	•				Stepper drives only
HP	4th Harmonic Filter Phase	•				Stepper drives only
IA	Immediate Analog			•	•	All drives
ID	Immediate Distance			•	•	All drives
IE	Immediate Encoder			•	•	Servo drives, drives with encoder
IF	Immediate Format	•			•	All drives
IQ	Immediate Current			•	•	Servo drives only
IP	Immediate Position			•	•	All drives
IT	Immediate Temperature			•	•	All drives
IU	Immediate Voltage			•	•	All drives
IV	Immediate Velocity			•	•	All drives
LP	Software Limit CW					All Step Servo drives and M2
LM	Software Limit CCW					All Step Servo drives and M2
LV	Low Voltage Threshold	•				All drives
MD	Motor Disable				•	All drives
ME	Motor Enable				•	All drives
MN	Model Number			•	•	All drives
MO	Motion Output	•				All drives
MR	Microstep Resolution	•				All drives (deprecated - see EG
MV	Model & Revision			•	•	All drives except Blu servos

OF	On Fault		•			Q drives only
OI	On Input		•			Q drives only
OP	Option Board	•		•	•	All drives
PA	Power-up Acceleration Current	•				
PC	Power up Current	•				All drives
PD	In Position Counts	•				All Step Servo drives and M2
PE	In Position Timing	•				All Step Servo drives and M2
PF	Position Fault	•				Servo drives, drives with encoder
PI	Power up Idle Current	•				Stepper drives only
PL	In Position Limit	•				Servo drives only
PM	Power up Mode	•				All drives
PP	Power up peak current	•				Servo drives only
PW	Pass Word		•			Q drives only
RE	Restart / Reset		•		•	All drives
RL	Register Load				•	All drives
RS	Request Status			•	•	All drives
RV	Revision Level			•	•	All drives
SA	Save all NV Parameters		•			All drives
SC	Status Code			•	•	
SD	Set Direction	•				STM stepper drives with Flex I/O
SF	Step Filter Frequency	•				Stepper drives only
SI	Enable Input usage	•				All drives
SK	Stop & Kill		•		•	All drives
TT	Pulse Complete Timing					All Step Servo drives and M2
ZC	Regen Resistor Continuous Wattage	•				BLuAC5 and STAC6 drives only
ZR	Regen Resistor Value	•				BLuAC5 and STAC6 drives only
ZT	Regen Resistor Peak Time	•				BLuAC5 and STAC6 drives only

11.3.4 I/O Commands

Command	Description	NV	write only	read only	Immediate	Compatibility
AD	Analog Deadband	•				All stepper drives and SV servo drives
AF	Analog Filter	•				All drives
AG	Analog Velocity Gain	•				All stepper drives and SV servo drives
AI	Alarm Input usage	•				All drives
AN	Analog Torque Gain	•				All Step Servo drives and M2 Servo drives
AO	Alarm Output usage	•				All drives
AP	Analog Position Gain	•				All drives
AS	Analog Scaling	•				All stepper drives and SV servo drives
AT	Analog Threshold	•				All drives

AV	Analog Offset	•				All drives
AZ	Analog Zero (Auto Zero)		•			All drives
BD	Brake Disengage Delay time	•				All drives
BE	Brake Engage Delay time	•				All drives
BO	Brake Output usage	•				All drives
DL	Define Limits	•				All drives
EI	Input Noise Filter	•				All drives
FI	Filter Input	•				All drives (Note: not NV on Blu servos)
FX	Filter Selected Inputs					Blu, STAC5, STAC6, SVAC3
IH	Immediate High Output		•		•	All drives
IL	Immediate Low Output		•		•	All drives
IO	Output Status				•	All drives
IS	Input Status request			•	•	All drives
MO	Motion Output	•				All drives
OI	On Input		•			Q drives only
SI	Enable Input usage	•				All drives
SO	Set Output		•			All drives
TI	Test Input		•			Q drives only
TO	Tach Output	•				TSM drives only
WI	Wait on Input		•			All drives

11.3.5 Communications Commands

Command	Description	NV	write only	read only	Immediate	Compatibility
BR	Baud Rate	•				All drives
BS	Buffer Status				•	All drives
CE	Communications Error				•	All drives
IF	Immediate Format	•			•	All drives
PB	Power up Baud Rate	•				All drives
PR	Protocol	•				All drives
TD	Transmit Delay	•				All drives

11.3.6 Q Program Commands

Command	Description	NV	write only	read only	Immediate	Compatibility
AX	Alarm Reset		•			All drives
MT	Multi-Tasking					Q drives only
NO	No Operation		•			Q drives only
OF	On Fault		•			Q drives only
OI	On Input		•			Q drives only
PS	Pause		•			All drives
QC	Queue Call		•			Q drives only

QD	Queue Delete		•			Q drives only
QE	Queue Execute		•		•	Q drives only
QG	Queue Goto		•			Q drives only
QJ	Queue Jump		•			Q drives only
QK	Queue Kill		•			Q drives only
QL	Queue Load		•		•	Q drives only
QR	Queue Repeat		•			Q drives only
QS	Queue Save		•		•	Q drives only
QU	Queue Upload			•	•	Q drives only
QX	Queue Load & Execute		•			Q drives only
SM	Stop Move		•			Q drives only
SS	Send String		•			All drives
TI	Test Input		•			Q drives only
WD	Wait Delay using Data Register		•			Q drives only
WI	Wait for Input		•			All drives
WM	Wait for Move to complete		•			Q drives only
WP	Wait for Position in complex move		•			Q drives only
WT	Wait Time		•			Q drives only

11.3.7 Register Commands

Command	Description	NV	write only	read only	Immediate	Compatibility
CR	Compare Register		•			Q drives only
DR	Data Register for Capture		•			Q drives only
RC	Register Counter		•			Q drives only
RD	Register Decrement		•			Q drives only
RI	Register Increment		•			Q drives only
RL	Register Load				•	Q drives only
RM	Register Move		•			Q drives only
RR	Register Read		•			Q drives only
RU	Register Upload		•		•	
RW	Register Write		•			Q drives only
RX	Register Load					Q drives only
R+	Register Addition		•			Q drives only
R-	Register Subtraction		•			Q drives only
R*	Register Multiplication		•			Q drives only
R/	Register Division		•			Q drives only
R&	Register Logical AND		•			Q drives only
R|	Register Logical OR		•			Q drives only
TR	Test Register		•			Q drives only
TS	Time Stamp read		•			Q drives only

11.4 Host Command Reference

Please download the latest Host Command Reference manual from our website www.applied-motion.com.

12 Appendix B: Q Programmer Reference

The use of SCL commands with Applied Motion Products dates back many years. A few years ago a new control platform was created that expanded the use of SCL commands and allowed users to create stored programs with SCL commands. These programs could be saved in a drive's non-volatile memory, and the drive could run these programs stand-alone, or without a permanent connection to the host. This expansion of SCL's capabilities was called Q, and since that time Applied Motion Products has continued to expand the offering of drives with the Q motion controller built in. By combining the ability to run a sophisticated, single-axis motion control program stand-alone and the ability to communicate serially to a host device, Q drives offer a high level of flexibility and functionality to the machine designer and system integrator. The characteristics are as follows:

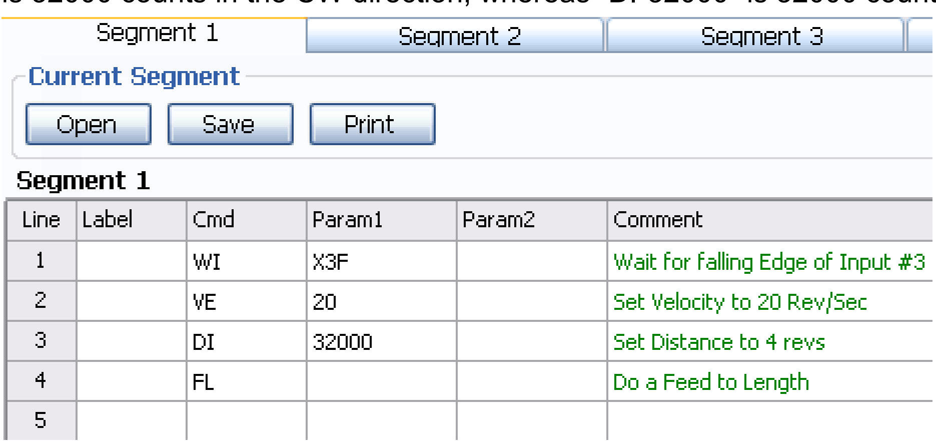
Single-Axis motion control
Stand-Alone program execution
Multi-tasking functionality
Conditional Processing
Math Calculation
Data register manipulation

12.1 Sample Command Sequences

The following are sequences of commands that give examples of how to create motion and logic within a Q program. All of the commands in this section are buffered-type commands.

Feed to Length

The FL (Feed to Length) command is used for relative (or incremental) moves. When executed, the motor will move a fixed distance, using linear acceleration and deceleration ramps and a maximum velocity. These move parameters are set using the DI (Distance), AC (Acceleration), DE (Deceleration), and VE (Velocity) commands. The direction of the move is determined by the sign of the DI parameter. "DI32000" is 32000 counts in the CW direction, whereas "DI-32000" is 32000 counts in the CCW direction.



Line	Label	Cmd	Param1	Param2	Comment
1		WI	X3F		Wait for falling Edge of Input #3
2		VE	20		Set Velocity to 20 Rev/Sec
3		DI	32000		Set Distance to 4 revs
4		FL			Do a Feed to Length
5					

Above is a sample sequence showing a move of 32000 counts at a velocity of 20 rps. The FL command initiates the move. The order of the VE and DI commands is not significant, except that any changes to the move parameters must be done before the FL command.

Feed to Position

The FP (Feed to Position) command is used for absolute moves. When executed, the motor will move to a position, with linear acceleration and deceleration ramps and a maximum velocity, based on the internal motor position of the drive. The move parameters are set using the AC, DE, VE and DI commands. In the case of the FP command, the DI command sets the motor position, not the relative move distance.

Segment 1 | Segment 2 | Segment 3

Current Segment

Open Save Print

Segment 1

Line	Label	Cmd	Param1	Param2	Comment
1		WI	X3F		Wait for falling Edge of Input #3
2		VE	20		Set Velocity to 20 Rev/Sec
3		DI	32000		Set Distance to 4 revs
4		FL			Do a Feed to Length
5		WT	1		Wait 1 second
6		DI	0		Set feed position to ""0""
7		FP			Do a Feed to Position
8					

Above is a sample sequence showing a move to motor position 32000 counts (motor may move CW or CCW depending on the actual motor position before the start of the move), with a velocity of 20 rps. Other commands to keep in mind when using absolute moves are the EP (Encoder Position) and SP (Set Position) commands. These commands allow for the encoder counts and absolute motor position counter to be set to zero at any time, by entering “EP0” followed by “SP0”. These positions may also be set to other values by entering the desired number directly. For more information, refer to the Host Command Reference.

Feed to Sensor

The FS (Feed to Sensor) command causes the motor to move at a fixed velocity until an input changes state. When the designated input changes state the motor decelerates to a stop. The parameters of the move are set by the AC, DE, VE and DI commands. In an FS command, the DI command sets both the distance in which the motor should stop after the input changes state and the direction of the move. Parameters for the FS command are the input number (0-7) and the input state the drive should look for: H (high), L (low), R (rising edge), or F (falling edge).

Segment 1 | Segment 2 | Segment 3

Current Segment

Open | Save | Print

Segment 1

Line	Label	Cmd	Param1	Param2	Comment
1		WI	X3F		Wait for falling Edge of Input #3
2		DL	3		Turn OFF limit detection
3		VE	5		Set Velocity to 5 Rev/Sec
4		DI	8000		Set offset Distance to 1 rev
5		FS	X7H		Do a Feed to Sensor (#7 high)
6		WT	1		Wait 1 second
7		VE	20		Set Velocity to 20 Rev/Sec
8		DI	0		Set feed position to ""0""
9		FP			Do a Feed to Position
10		DL	2		Turn ON limit detection

Above is an example where the motor will move in the clockwise direction at a maximum speed of 5 rps, until drive input X7 goes high, at which point the drive will use the distance set in the DI command (8000 counts) and the deceleration rate set in the DE command to bring the motor to a stop.

Looping

There are two ways to accomplish looping, or repeat loops, within a program. The first method is to create an infinite loop by using the QG (Queue GoTo) command. The parameter for this command is a line number in the segment, and whenever the sequence gets to the QG command the segment will jump to the designated line.

Segment 1 | Segment 2

Current Segment

Open | Save | Print

Segment 1

Line	Label	Cmd	Param1	Param2
1	Label1	DI	40000	
2		AC	500	
3		DE	500	
4		VE	20	
5		FL		
6		WT	0.5	
7		QG	#Label1	

In the example to above, the sequence contains an FL command, with related parameter commands ahead of it (AC, DE, DI, VE). After the FL command is a WT (Wait Time) command with a time of 0.5 seconds, and then a QG command that points to line 1. This sequence will loop forever with the segment always starting at line one after executing the QG command.

Segment 1 | Segment 2

Current Segment

Open | Save | Print

Segment 1

Line	Label	Cmd	Param1	Param2
1		RX	3	5
2	Label1	DI	40000	
3		AC	500	
4		DE	500	
5		VE	20	
6		FL		
7		WT	0.5	
8		QR	3	#Label1
9				

The second method shown above for looping utilizes the QR (Queue Repeat) command. It works by jumping to a given segment line for the number of times indicated in a user-defined data register. Any user-defined data register will work. In the example to the right, the QG command from the previous example has been replaced with the QR command, and parameters have been added. In this sequence the segment will jump to line 2 for the number of times indicated in register 3. Notice on line 1 of the segment that data register 3 has been loaded (using the RX command) with the value 5. Therefore, the FL command in this example (as well as the DI, AC, DE, VE and WT commands) will repeat five times.

Branching

Branching in a program is done using the QJ (Queue Jump) command. Branching is different than looping in that a branch (or jump) is done based on a tested condition. The QJ command will always work in conjunction with one other command: TI (Test Input), TR (Test Register), or CR (Compare Register).

Segment 1 | Segment 2

Current Segment

Open | Save | Print

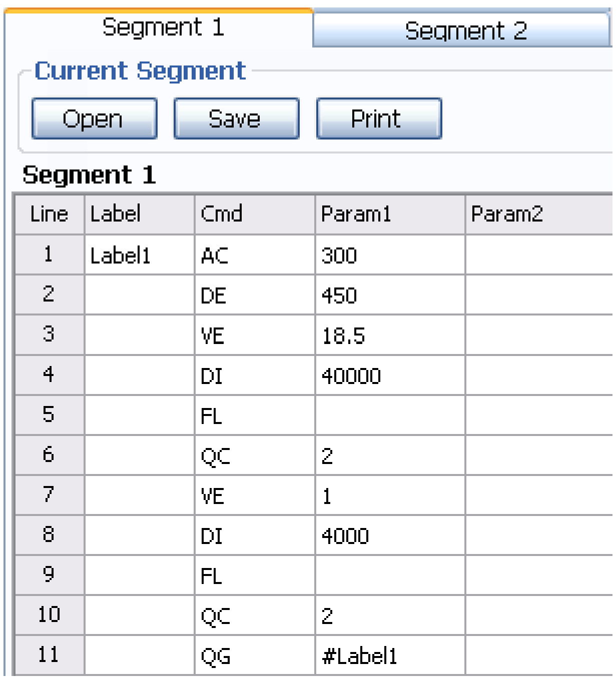
Segment 1

Line	Label	Cmd	Param1	Param2
1	Label2	AC	300	
2		DE	450	
3		VE	18.5	
4		WT	0.25	
5		TI	5L	
6		QJ	T	#Label1
7		DI	50000	
8		FL		
9		QG	#Label2	
10	Label1	DI	-50000	
11		FL		
12		QG	#Label2	

Let’s say we have an application with two possible moves. We always want to make a CW move, unless input X5 is low in which case we want to make a CCW move. In this example we set all of the move parameters except distance at the top of the segment. We set accel to 300 rps/s, decel to 450 rps/s, and velocity to 18.5 rps. There is a WT (Wait Time) of 0.25 seconds so that we may have a noticeable delay between moves. Then, we test input X5 for a low condition using the TI (Test Input) command. If it is true (i.e. input X5 is low), we branch (using QJ) to line 10, set the distance to -50000 counts and make a CCW move with FL. Otherwise the program proceeds to line 7, sets the distance to 50000 counts and makes the CW move. To prevent the CCW move from happening right after the CW move, and to continuously repeat the segment, QG commands are placed after each FL command.

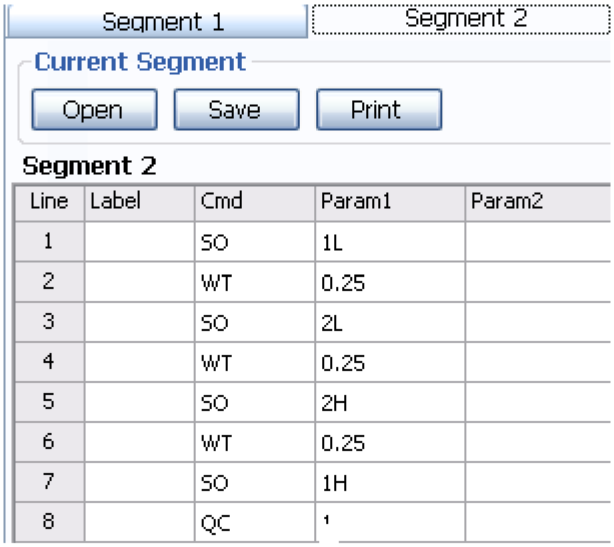
Calling

Calling is similar to using sub-routines. The QC (Queue Call) command allows us to exit a segment, execute another segment, and then return to the original segment to the line where the “call” was initiated. This is useful when we have a sequence of commands that is used over and over within a program. Rather than repeatedly program these commands into our segment(s), we locate the frequently-used sequence in its own segment, and then call that segment whenever we need to.



Line	Label	Cmd	Param1	Param2
1	Label1	AC	300	
2		DE	450	
3		VE	18.5	
4		DI	40000	
5		FL		
6		QC	2	
7		VE	1	
8		DI	4000	
9		FL		
10		QC	2	
11		QG	#Label1	

In the above example we are making two distinct moves (FL), one fast move and one slow move. After each move we’d like to turn 2 outputs on and off. To accomplish this using the QC command, we must program two segments. In this example, segment 1 is the primary (or calling) segment, and in it we program the two distinct FL commands. We are using the same accel and decel rates for the two moves, but the velocities and distances change. After each move we’d like to set outputs Y1 and Y2 on then off, and rather than entering the necessary commands to do this after each FL command in segment 1, we place the commands in segment 2 and then use the QC command to call it.



Line	Label	Cmd	Param1	Param2
1		SO	1L	
2		WT	0.25	
3		SO	2L	
4		WT	0.25	
5		SO	2H	
6		WT	0.25	
7		SO	1H	
8		QC		

In segment 2 shown above we place the desired SO (Set Output) commands that turns on output Y1 followed by output Y2. Then output Y2 is turned off along with output Y1 after it. Notice we've placed WT (Wait Time) commands of 0.25 seconds between each SO command to make the changing output states more noticeable. Segments 1 and 2 work together in this example: when segment 1 reaches its first QC command (with the parameter "2" indicating segment 2), the subroutine to control the outputs in segment 2 will be run and call segment 1 when finished. Notice at the end of the sequence in segment 2 we've placed a QC command with no parameter. A QC command with no parameter means return to the original, calling line and segment. This results in the program returning to segment 1, completing the second move, calling segment 2 again, returning to segment 1 once more, and then starting the process over by looping to line 1 ("QG1").

Multi-tasking

The multi-tasking feature of Q drives allows you to initiate a move command (FL, FP, CJ, FS, etc.) and proceed to execute other commands without waiting for the move command to finish. Without multi-tasking (or more accurately with multi-tasking turned off), a Q drive always executes commands in succession by waiting for the completion of a particular command before moving on to the next command. In the case of move commands, this means waiting for the move to finish before executing subsequent commands. For example, if you have an FL command (Feed to Length - incremental move) followed by an SO command (Set Output), the drive will wait to finish the motor move before setting the drive's digital output.

With multi-tasking turned on, a Q drive initiates a move command and then immediately proceeds to execute subsequent commands. For example, by doing the same FL and SO commands as described in the example above, but with multi-tasking turned on, the drive will initiate the move and immediately proceed to execute the set output command without waiting for the move to finish. Multi-tasking is turned on and off with the MT command. "MT1" turns multi-tasking on, and "MT0" turns it off.

To illustrate the use of the MT command, here are a couple of sample command sequences.

Segment 1 | Segment 2

Current Segment

Open Save Print

Line	Label	Cmd	Param1	Param2
1		MT	0	
2		FL		
3		WT	0.5	
4		SO	1L	

In the above command sequence, notice that multi-tasking is turned off, “MT0”. When this sequence is executed by a drive, the FL (Feed to Length) incremental move will complete before the drive waits 0.5 seconds (WT0.50) and then sets output 1 low (SOY1L).

Segment 1 | Segment 2

Current Segment

Open Save Print

Segment 2

Line	Label	Cmd	Param1	Param2
1		MT	1	
2		FL		
3		WT	0.5	
4		SO	1L	

In the above command sequence with multi-tasking turned on, “MT1”, the drive will not wait for the FL command to complete before executing the WT and SO commands. In other words, the drive will initiate the FL command, then wait 0.50 seconds, and then set output 1 low. If the last distance set by the DI command is sufficiently long, the drive’s output 1 will be set low before the FL command has completed. This example is actually quite basic, even though it illustrates the function of multi-tasking well. If you try these sequences with your drive, make sure the last DI command is sufficiently large enough to see a noticeable difference in when the drive sets the output.

NOTE: Because it is physically impossible for a motor to make two moves at the same time, move commands are always blocked even with Multi-tasking turned on. For example, if you have Multi-tasking turned on and the program has two move commands in a row, the drive will wait and execute the second move command only when the first move has finished.

13 Appendix C: CANopen Reference

13.1 CANopen Communication

CANopen is a communication protocol and device profile specification for embedded systems used in automation. In terms of the OSI model, CANopen implements the layers above and including the network layer. The CANopen standard consists of an addressing scheme, several small communication protocols and an application layer defined by a device profile. The communication protocols have support for network management, device monitoring and communication between nodes, including a simple transport layer for message segmentation/desegmentation. The lower level protocol implementing the data link and physical layers is usually Controller Area Network (CAN).

The basic CANopen device and communication profiles are given in the CiA 301 specification released by CAN in Automation.[1] Profiles for more specialized devices are built on top of this basic profile, and are specified in numerous other standards released by CAN in Automation, such as CiA 401[2] for I/O-modules and CiA 402[3] for motion control.

13.2 Why CANopen

Multi-axis Control

Up to 127 axes can be supported via CANopen, and the maximum communication baud rate is up to 1Mbps.

A further advantage with CAN is the Multi-Master Capability. This means that each user on the bus has the same access rights. The access authorization alone controls the users among one another via the priority of the communication objects and their identifiers (arbitration). This allows direct communication between the individual users without a time-consuming "detour" over a central master.

Easy Wiring

A shielded twisted pair cable is be used as the bus cable. Less cable will cause less chance of error, reduce the wiring cost, labor cost, whilst maintaining availability and minimizing cost.

13.3 CANopen Example Programs

13.3.1 Profile Position Mode

**** Enable Motor Power - CiA 402 State Machine ****

ID DLC Data

$0603 $8 $2B $40 $60 $00 $06 $00 $00 $00 ‘Ready to Switch on

$0603 $8 $2B $40 $60 $00 $07 $00 $00 $00 ‘Switched on

$0603 $8 $2B $40 $60 $00 $0F $00 $00 $00 ‘Operation Enabled

**** Set to Profile Position Mode ****

$0603 $8 $2F $60 $60 $00 $01 $00 $00 $00 ‘Set to Profile Position Mode

**** Set Motion Parameters ****

$0603 $8 $23 $81 $60 $00 $F0 $00 $00 $00 ‘Set Profile Velocity to 1 rps

$0603 $8 $23 $83 $60 $00 $58 $02 $00 $00 ‘Set Acceleration to 100 rps/s

$0603 $8 $23 $84 $60 $00 $58 $02 $00 $00 ‘Set Deceleration to 100 rps/s

Single Move Absolute

$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 200000 steps

$0603 $8 $2B $40 $60 $00 $1F $00 $00 $00 ‘Set New Set Point Bit to 1

$0603 $8 $2B $40 $60 $00 $0F $00 $00 $00 ‘Clear New Set Point Bit
Single Move Relative
$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 200000 steps
$0603 $8 $2B $40 $60 $00 $5F $00 $00 $00 ‘Set New Set Point Bit to 1
$0603 $8 $2B $40 $60 $00 $4F $00 $00 $00 ‘Clear New Set Point Bit
Multiple Move, Stopping between Moves
$0603 $8 $23 $81 $60 $00 $B0 $04 $00 $00 ‘Set Profile Velocity to 5 rps
$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 200000 steps
$0603 $8 $2B $40 $60 $00 $5F $00 $00 $00 ‘Set New Set Point Bit to 1
$0603 $8 $2B $40 $60 $00 $4F $00 $00 $00 ‘Clear New Set Point Bit
$0603 $8 $23 $81 $60 $00 $60 $09 $00 $00 ‘Set Profile Velocity to 10 rps
$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 600000 steps
$0603 $8 $2B $40 $60 $00 $5F $00 $00 $00 ‘Set New Set Point Bit to 1
$0603 $8 $2B $40 $60 $00 $4F $00 $00 $00 ‘Clear New Set Point Bit
Multiple Move, Continuous Motion
$0603 $8 $23 $81 $60 $00 $B0 $04 $00 $00 ‘Set Profile Velocity to 5 rps
$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 200000 steps
$0603 $8 $2B $40 $60 $00 $5F $02 $00 $00 ‘Set New Set Point Bit to 1
$0603 $8 $2B $40 $60 $00 $4F $02 $00 $00 ‘Clear New Set Point Bit
$0603 $8 $23 $81 $60 $00 $60 $09 $00 $00 ‘Set Profile Velocity to 10 rps
$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 600000 steps
$0603 $8 $2B $40 $60 $00 $5F $02 $00 $00 ‘Set New Set Point Bit to 1
$0603 $8 $2B $40 $60 $00 $4F $02 $00 $00 ‘Clear New Set Point Bit
Multiple Move, Immediate Change in Motion
$0603 $8 $23 $81 $60 $00 $B0 $04 $00 $00 ‘Set Profile Velocity to 5 rps
$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 200000 steps
$0603 $8 $2B $40 $60 $00 $7F $02 $00 $00 ‘Set New Set Point Bit to 1
$0603 $8 $2B $40 $60 $00 $6F $02 $00 $00 ‘Clear New Set Point Bit
$0603 $8 $23 $81 $60 $00 $60 $09 $00 $00 ‘Set Profile Velocity to 10 rps
$0603 $8 $23 $7A $60 $00 $40 $0D $03 $00 ‘Set Target Position to 600000 steps
$0603 $8 $2B $40 $60 $00 $7F $02 $00 $00 ‘Set New Set Point Bit to 1
$0603 $8 $2B $40 $60 $00 $6F $02 $00 $00 ‘Clear New Set Point Bit

13.3.2 Profile Velocity Mode

**** Enable Motor Power - CiA 402 State Machine ****
ID DLC Data
$0603 $8 $2B $40 $60 $00 $06 $00 $00 $00 ‘Ready to Switch on
$0603 $8 $2B $40 $60 $00 $07 $00 $00 $00 ‘Switched on
$0603 $8 $2B $40 $60 $00 $0F $01 $00 $00 ‘Operation Enabled; Motion Halted

**** Set to Profile Velocity Mode ****

$0603 $8 $2F $60 $60 $00 $03 $00 $00 $00 ‘Set to Profile Velocity Mode

**** Set Motion Parameters ****

$0603 $8 $23 $FF $60 $00 $F0 $00 $00 $00 ‘Set Target Velocity to 1 rps

$0603 $8 $23 $83 $60 $00 $58 $02 $00 $00 ‘Set Acceleration to 100 rps/s

$0603 $8 $23 $84 $60 $00 $58 $02 $00 $00 ‘Set Deceleration to 100 rps/s

**** Start/Stop Motion ****

$0603 $8 $2B $40 $60 $00 $0F $00 $00 $00 ‘Motion Starts

$0603 $8 $23 $FF $60 $00 $60 $09 $00 $00 ‘Change Target Velocity to 10 rps

$0603 $8 $2B $40 $60 $00 $0F $01 $00 $00 ‘Motion Halts

13.3.3 Homing Mode

**** Enable Motor Power - CiA 402 State Machine ****

ID DLC Data

$0603 $8 $2B $40 $60 $00 $06 $00 $00 $00 ‘Ready to Switch on

$0603 $8 $2B $40 $60 $00 $07 $00 $00 $00 ‘Switched on

$0603 $8 $2B $40 $60 $00 $0F $00 $00 $00 ‘Operation Enabled

**** Set to Homing Mode ****

$0603 $8 $2F $60 $60 $00 $06 $00 $00 $00 ‘Set to Homing Mode

$0603 $8 $2F $98 $60 $00 $13 $00 $00 $00 ‘Set Homing Method to 19

**** Set Motion Parameters ****

$0603 $8 $23 $9A $60 $00 $58 $02 $00 $00 ‘Set Homing Acceleration to 100rps/s

$0603 $8 $23 $99 $60 $01 $F0 $00 $00 $00 ‘Set Homing Velocity (Search for Switch) to 1rps

$0603 $8 $23 $99 $60 $02 $78 $00 $00 $00 ‘Set Index Velocity (Search for Index or Zero) to 0.5rps

$0603 $8 $23 $7C $60 $00 $40 $9C $00 $00 ‘Set Homing Offset to 40000 Steps

$0603 $8 $2F $01 $70 $00 $03 $00 $00 $00 ‘Set Homing Switch to Input 3

**** Start/Stop Homing ****

$0603 $8 $2B $40 $60 $00 $1F $00 $00 $00 ‘Homing Starts

$0603 $8 $2B $40 $60 $00 $1F $01 $00 $00 ‘Homing Stops

13.3.4 Normal Q Mode

**** Enable Motor Power - CiA 402 State Machine ****

ID DLC Data

$0603 $8 $2B $40 $60 $00 $06 $00 $00 $00 ‘Ready to Switch on

$0603 $8 $2B $40 $60 $00 $07 $00 $00 $00 ‘Switched on

$0603 $8 $2B $40 $60 $00 $0F $00 $00 $00 ‘Operation Enabled

**** Set to Normal Q Mode ****

$0603 $8 $2F $60 $60 $00 $FF $00 $00 $00 ‘Set to Normal Q Mode

$0603 $8 $2F $07 $70 $00 $01 $00 $00 $00 ‘Set Q Segment Number to 1

**** Start/Stop Q Program ****

$0603 $8 $2B $40 $60 $00 $1F $00 $00 $00 ‘Q Program Starts

$0603 $8 $2B $40 $60 $00 $1F $01 $00 $00 ‘Q Program Halts

13.3.5 Sync Q Mode

**** Enable Motor Power - CiA 402 State Machine ****

ID DLC Data

$0603 $8 $2B $40 $60 $00 $06 $00 $00 $00 ‘Ready to Switch on

$0603 $8 $2B $40 $60 $00 $07 $00 $00 $00 ‘Switched on

$0603 $8 $2B $40 $60 $00 $0F $00 $00 $00 ‘Operation Enabled

**** Set to Sync Q Mode ****

$0603 $8 $2F $60 $60 $00 $FE $00 $00 $00 ‘Set to Sync Q Mode

$0603 $8 $2F $07 $70 $00 $01 $00 $00 $00 ‘Set Q Segment Number to 1

$0603 $8 $23 $05 $10 $00 $80 $00 $00 $00 ‘Set Sync Pulse to 0x80

**** Start/Stop Q Program ****

$80 $0 ‘Q Program Starts

$0603 $8 $2B $40 $60 $00 $0F $01 $00 $00 ‘Q Program Halts

13.3.6 PDO Mapping

****Mapping TPDO2 ****

$0000 $2 $80 $03 ‘Return back to “Pre-Operational” Mode

$0603 $8 $23 $01 $18 $01 $80 $02 $00 $80 ‘Turn off the TPDO2

$0603 $8 $2F $01 $1A $00 $00 $00 $00 $00 ‘Set Number of Mapped objects to zero

$0603 $8 $23 $01 $1A $01 $10 $00 $41 $61 ‘Map object1(0x6041) to TPDO2 subindex1.

$0603 $8 $23 $01 $1A $02 $20 $00 $0A $70 ‘Map object2(0x700A) to TPDO2 subindex2.

$0603 $8 $2F $01 $1A $00 $02 $00 $00 $00 ‘Set Number of total Mapped objects to Two

$0603 $8 $23 $01 $18 $01 $80 $02 $00 $00 ‘Turn on the TPDO2

13.4 Downloads

Eds Download	Link
CANopen User Manual	Link

14 Appendix D: Modbus/RTU Reference

The Modbus products from Applied Motion Products are based on a serial communication bus with Modbus/RTU.

Modbus communication protocol is an industrial fieldbus communication protocol, which uses the application layer of the OSI 7-packet transport protocol. It defines a device controller which can identify the

frame structure and information. It is independent of the physical medium and can be used over various networks.

Because Modbus is a master/slave protocol, only one node can be a master and the others, slave nodes. Each device that is intended to communicate using Modbus is given a unique address. In serial networks, only the node assigned as the Master may initiate a command.

A Modbus command contains the Modbus address of the device for which it is intended. Only the intended device will act on the command, even though other devices might receive it (an exception is specific broadcast commands sent to node 0 which are acted on but not acknowledged). All Modbus commands contain checksum information, to allow the recipient to detect transmission errors. The basic Modbus commands can instruct an RTU (remote terminal unit) to change the value in one of its registers, control or read an I/O port, and command the device to send back one or more values contained in its registers.

14.1 Communication Address

In the network system, each drive requires a unique drive address. Only the drive with the matching address will respond to the host command. In a Modbus network, address "0" is the broadcast address. It cannot be used for an individual drive address. Modbus RTU/ASCII can set drive addresses from 1 to 31.

14.2 Data Encoding

Big-endian: The most significant byte (MSB) value is stored at the memory location with the lowest address; the next byte value in significance is stored at the following memory location and so on. This is akin to Left-to-Right reading in hexadecimal order.

For example: To store a 32bit data 0x12345678 into register address 40031 and 40032. 0x1234 will be defined as MSB, and 0x5678 as LSB. With big-endian system

Register 40031 = 0x1234

Register 40032 = 0x5678

When transferring 0x12345678, the first word will be 0x1234, and the second word will be 0x5678

Little-endian: The most significant byte (MSB) value is stored at the memory location with the highest address; the next byte value of significance is stored at the following memory location and so on.

For example: To store a 32bit data 0x12345678 into register address 40031 and 40032. 0x5678 will be defined as MSB, and 0x1234 as LSB. With little-endian system

Register 40031 = 0x5678

Register 40032 = 0x1234

When transferring 0x12345678, the first words will be 0x5678, and the second words will be 0x1234

PR defines data transfer type.

14.3 Communication Baud Rate & Protocol

Step servo has a fixed communication data framing: 8,N,1. Date bits: 8, parity checking: none, stop bit: 1.

BR and **PB** define the communication baud rate.

In serial communication, changing the baud rate will NOT take effect immediately; it will ONLY take effect at the next power up of the drive.

1 = 9600bps

2 = 19200bps

3 = 38400bps

4 = 57600bps

5 = 115200bps

14.4 Function Code

Applied Motion Products drives currently support following Modbus function code:

1) 0x03: Read holding registers
2) 0x04: Read input registers
3) 0x06: Write single registers
4) 0x10: Write multiple registers

14.5 Modbus/RTU Data Frame

Modbus RTU is a master and slave communication system. The CRC checking code includes from drive's address bits to data bits. This standard data framing are as follows:

Address	Function Code	Data	CRC

Based on data transfer status, there can be two types of response codes:

Normal Modbus response:

Response function code = request function code

Modbus error response:

Response function code = request function code + 0x80

The Error code is used to indicate the error reason.

Modbus Register Table

Modbus Register Table				
Register	**Access**	**Data Type**	**SCL Command**	**Map Register**
40001	Read	SHORT	Alarm Code (AL)	f
40002	Read	SHORT	Status Code (SC)	s
40003	Read	SHORT	Immediate Expanded Inputs (IS)	y
40004	Read	SHORT	Driver Board Inputs (ISX)	i
40005..6	Read	LONG	Encoder Position (IE, EP)	e
40007..8	Read	LONG	Immediate Absolute Position	l
40009..10	Write	LONG	Absolute Position Command	P
40011	Read	SHORT	Immediate Actual Velocity (IV0)	v
40012	Read	SHORT	Immediate Target Velocity (IV1)	w
40013	Read	SHORT	Immediate Drive Temperature (IT)	t
40014	Read	SHORT	Immediate Bus Voltage (IU)	u
40015..16	Read	LONG	Immediate Position Error (IX)	x
40017	Read	SHORT	Immediate Analog Input Value (IA)	a

40018	Read	SHORT	Q Program Line Number	b
40019	Read	SHORT	Immediate Current Command (IC)	c
40020..21	Read	LONG	Relative Distance (ID)	d
40022..23	Read	LONG	Sensor Position	g
40024	Read	SHORT	Condition Code	h
40025	Read	SHORT	Analog Input 1 (IA1)	j
40026	Read	SHORT	Analog Input 2 (IA2)	k
40027	Read	SHORT	Command Mode (CM)	m
40028	R/W	SHORT	Point-to-Point Acceleration (AC)	A
40029	R/W	SHORT	Point-to-Point Deceleration (DE)	B
40030	R/W	SHORT	Velocity (VE)	V
40031..32	R/W	LONG	Point-to-Point Distance (DI)	D
40033..34	R/W	LONG	Change Distance (DC)	C
40035	R/W	SHORT	Change Velocity (VC)	U
40036	Read	SHORT	Velocity Move State	n
40037	Read	SHORT	Point-to-Point Move State	o
40038	Read	SHORT	Q Program Segment Number	p
40039	Read	SHORT	Average Clamp Power (regen)	r
40040	Read	SHORT	Phase Error	z
40041..42	R/W	LONG	Position Offset	E
40043	R/W	SHORT	Miscellaneous Flags	F
40044	R/W	SHORT	Current Command (GC)	G
40045..46	R/W	LONG	Input Counter	I
40047	R/W	SHORT	Jog Accel (JA)	
40048	R/W	SHORT	Jog Decel (JL)	
40049	R/W	SHORT	Jog Velocity (JS)	J
40050	R/W	SHORT	Accel/Decel Current (CA)	
40051	R/W	SHORT	Running Current (CC)	N
40052	R/W	SHORT	Idle Current (CI)	
40053	R/W	SHORT	Steps per Revolution	R
40054	R/W	SHORT	Pulse Counter	S

40055	R/W	SHORT	Time Stamp	W
40056	R/W	SHORT	Analog Position Gain (AP)	X
40057	R/W	SHORT	Analog Threshold (AT)	Y
40058	R/W	SHORT	Analog Offset (AV	Z
40059..60	R/W	LONG	Accumulator	0
40061..62	R/W	LONG	User Defined	1
40063..64	R/W	LONG	User Defined	2
40065..66	R/W	LONG	User Defined	3
40067..68	R/W	LONG	User Defined	4
40069..70	R/W	LONG	User Defined	5
40071..72	R/W	LONG	User Defined	6
40073..74	R/W	LONG	User Defined	7
40075..76	R/W	LONG	User Defined	8
40077..78	R/W	LONG	User Defined	9
40079..80	R/W	LONG	User Defined	:
40081..82	R/W	LONG	User Defined	;
40083..84	R/W	LONG	User Defined	<
40085..86	R/W	LONG	User Defined	=
40087..88	R/W	LONG	User Defined	>
40089..90	R/W	LONG	User Defined	?
40091..92	R/W	LONG	User Defined	@
40093..94	R/W	LONG	User Defined	[
40095..96	R/W	LONG	User Defined	\
40097..98	R/W	LONG	User Defined	]
40099..100	R/W	LONG	User Defined	^
40101..102	R/W	LONG	User Defined	_
400103..104	R/W	LONG	User Defined	`
40105	R/W	SHORT	Brake Release Delay	
40106	R/W	SHORT	Brake Engage Delay	
40107	R/W	SHORT	Idle Current Delay	
40108	R/W	SHORT	Hyperbolic Smoothing Gain	

40109	R/W	SHORT	Hyperbolic Smoothing Phase	
40110	R/W	SHORT	Analog Filter Gain	
40111..124			(reserved)	
40125	R/W	SHORT	Command Opcode	
40126	R/W	SHORT	Parameter 1	
40127	R/W	SHORT	Parameter 2	
40128	R/W	SHORT	Parameter 3	
40129	R/W	SHORT	Parameter 4	
40130	R/W	SHORT	Parameter 5	

Command Opcode description

Register 40125 is defined as command Opcode, when following command is entered into register, the drive will execute the corresponding operation.

1) SCL Command Encoding Table

SCL Command Encoding Table							
Function	SCL	Opcode	Parameter1	Parameter2	Parameter3	Parameter4	Parameter5
Alarm Reset	AX	0xBA	×	×	×	×	×
Start Jogging	CJ	0x96	×	×	×	×	×
Stop Jogging	SJ	0xD8	×	×	×	×	×
Encoder Function	EF	0xD6	0,1,2 or 6	×	×	×	×
Encoder Position	EP	0x98	Position	×	×	×	×
Feed to Double	FD	0x69	I/O Point 1	Condition 1	I/O Point 2	Condition 2	×
Follow Encoder	FE	0xCC	I/O Point	Condition	×	×	×
Feed to Length	FL	0x66	×	×	×	×	×
Feed to Sensor with	FM	0x6A	I/O Point	Condition	×	×	×
Feed and Set Output	FO	0x68	I/O Point	Condition	×	×	×
Feed to Position	FP	0x67	×	×	×	×	×
Feed to Sensor	FS	0x6B	I/O Point	Condition	×	×	×
Feed to Sensor with	FY	0x6C	I/O Point	Condition	×	×	×
Jog Disable	JD	0xA3	×	×	×	×	×
Jog Enable	JE	0xA2	×	×	×	×	×
Motor Disable	MD	0x9E	×	×	×	×	×

Motor Enable	ME	0x9F	×	×	×	×	×
Seek Home	SH	0x6E	I/O Point	Condition	×	×	×
Set Position	SP	0xA5	Position	×	×	×	×
Filter Input	FI	0xC0	I/O Point	Filter Time	×	×	×
Filter Select Inputs	FX	0xD3	×	×	×	×	×
Step Filter Freq	SF	0x06	Freq	×	×	×	×
Analog Deadband	AD	0xD2	0.001 V	×	×	×	×
Alarm Reset Input	AI	0x46	Function	I/O Point	×	×	×
Alarm Output	AO	0x47	Function	I/O Point	×	×	×
Analog Scaling	AS	0xD1	×	×	×	×	×
Define Limits	DL	0x42	1..3	×	×	×	×
Set Output	SO	0x8B	I/O Point	Condition	×	×	×
Wait for Input	WI	0x70	×	×	×	×	×
Queue Load &	QX	0x78	1..12	×	×	×	×
Wait Time	WT	0x6F	0.01 sec	×	×	×	×
Stop Move, Kill Buffer	SK	0xE1	×	×	×	×	×
Stop Move, Kill	SKD	0xE2	×	×	×	×	×

For more detailed command functions description, please refer to **Host Command Reference manual.**

2) Digital I/O Function Selection and I/O Status table

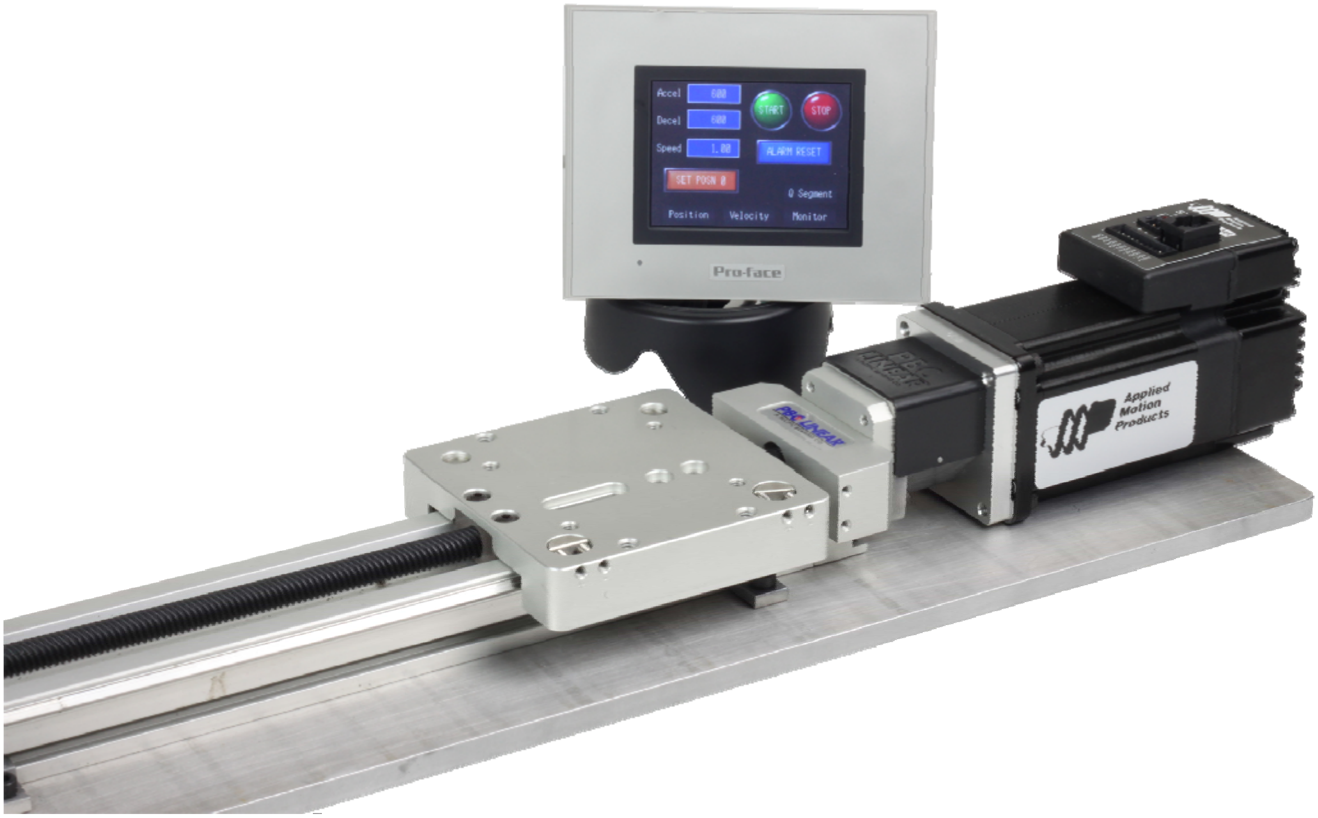
Character	hex code	
‘0’	0x30	Index of encode
‘1’	0x31	input 1 or output 1
‘2’	0x32	input 2 or output 2
‘3’	0x33	input 3 or output 3
‘4’	0x34	input 4 or output 4
‘L’	0x4C	low state (closed)
‘H’	0x48	high state (open)
‘R’	0x52	rising edge
‘F’	0x46	falling edge

14.6 Application Note: Modbus/RTU from Pro-face HMI

Introduction

This exercise demonstrates the connection and control of an Applied Motion Products STM24QF-3AE integrated stepper drive by a Proface GP4201 HMI. The HMI will be programmed to command simple moves and to monitor the STM24 using Modbus/RTU protocol and RS-232 communication

Your STM24 must have DSP firmware version 1.06 or later to support Modbus/RTU.

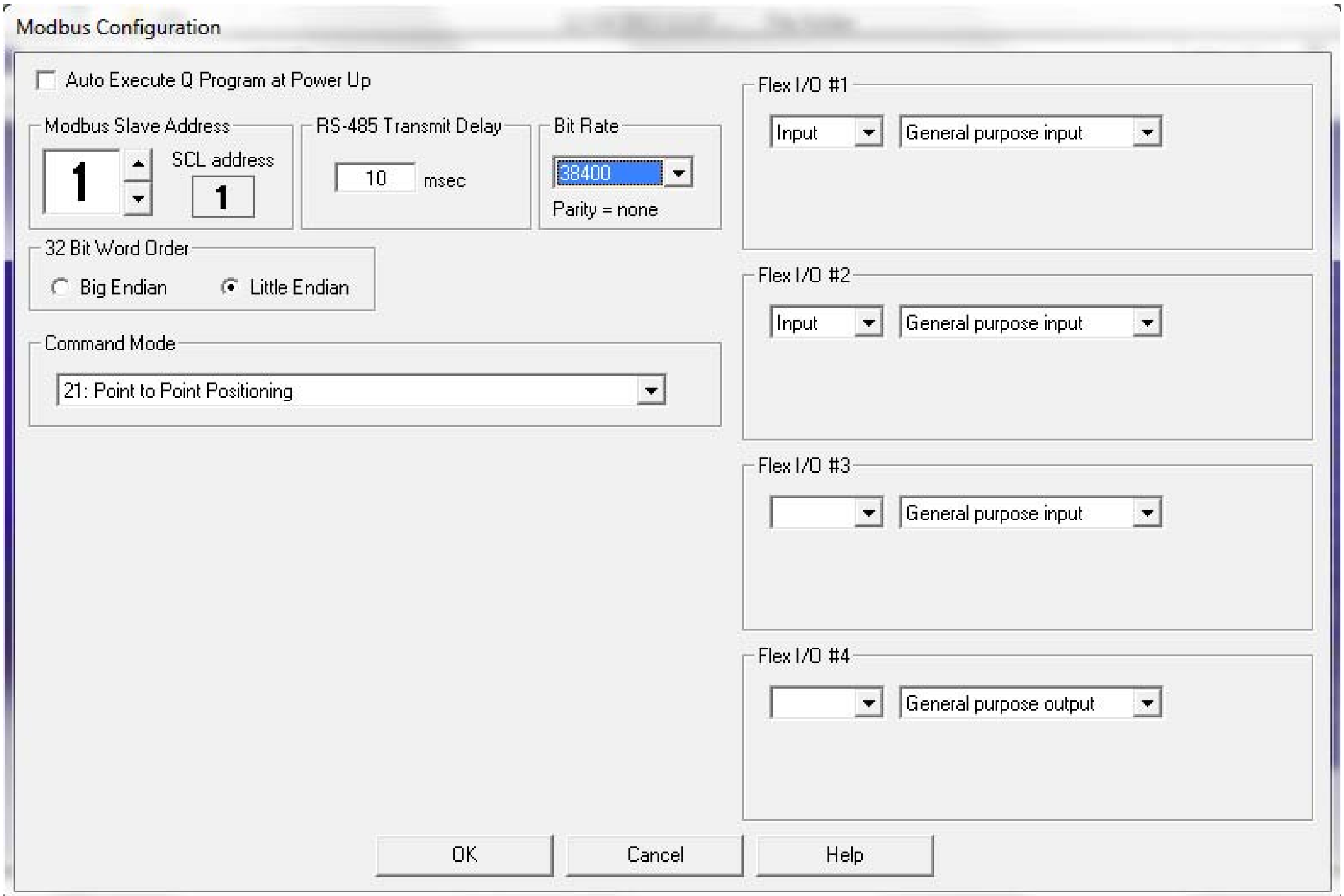


Serial Connection

Modbus/RTU can use RS-232, RS-422 or RS-485 as a physical layer. It can use any bit rate and any choice of parity and stop bits. It is the job of the user to make sure both sides are set the same and properly connected. This exercise uses an RS-232, three wire connection (RX, TX, GND), 38400 bps and no parity. The GP4201 includes an RS-232 communication port with a DB-9 male connector that couples directly to the standard programming and configuration cable that ships with the STM24.

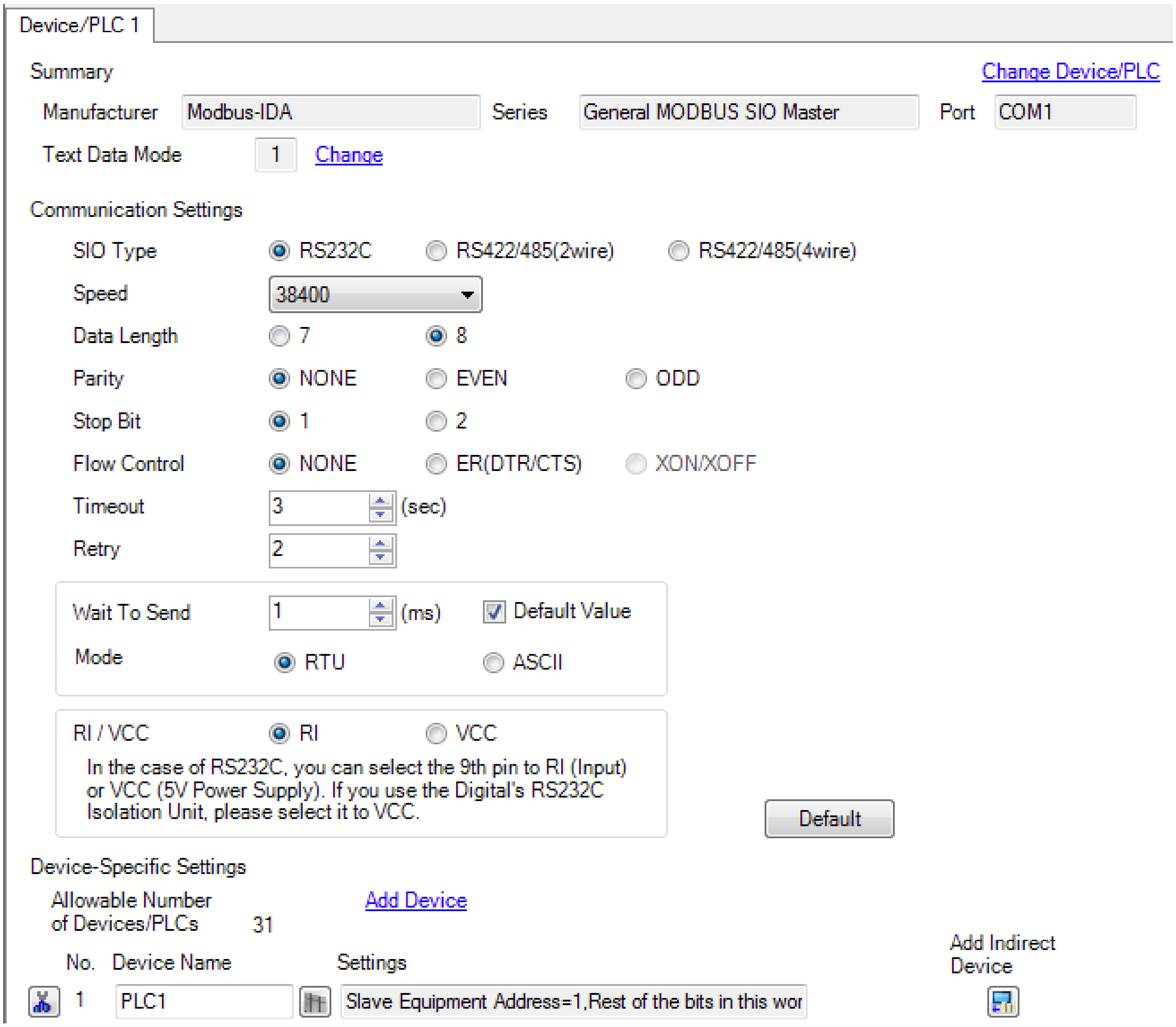
Serial Port Settings

On the drive end: use ST Configurator to set the drive for Modbus mode, command mode 21 (point to point positioning), 38400 bps. Our drives are always set for “no parity”. This is also the place to enter the drive’s slave address. ***ST Configurator 3.3.6* or later is required for Modbus support.**



After downloading to the drive and closing *ST Configurator*, be sure to power cycle the STM24 so it wakes up at the correct bit rate.

At the HMI end, the drive is connected to the GP4201 RS-232 comm. port, leaving two USB ports and an Ethernet connection for programming the HMI from a PC. This RS-232 port is configured in the GP-Pro EX software by going to the Project Window and double clicking Device/PLC. Be sure to set the Manufacturer to “Modbus - IDA” and the Series to “General MODBUS SIO Master”. The Port should be set to COM1. Be sure to set the slave address to match the STM24 setting that was entered into *ST Configurator*, in this case “1”.



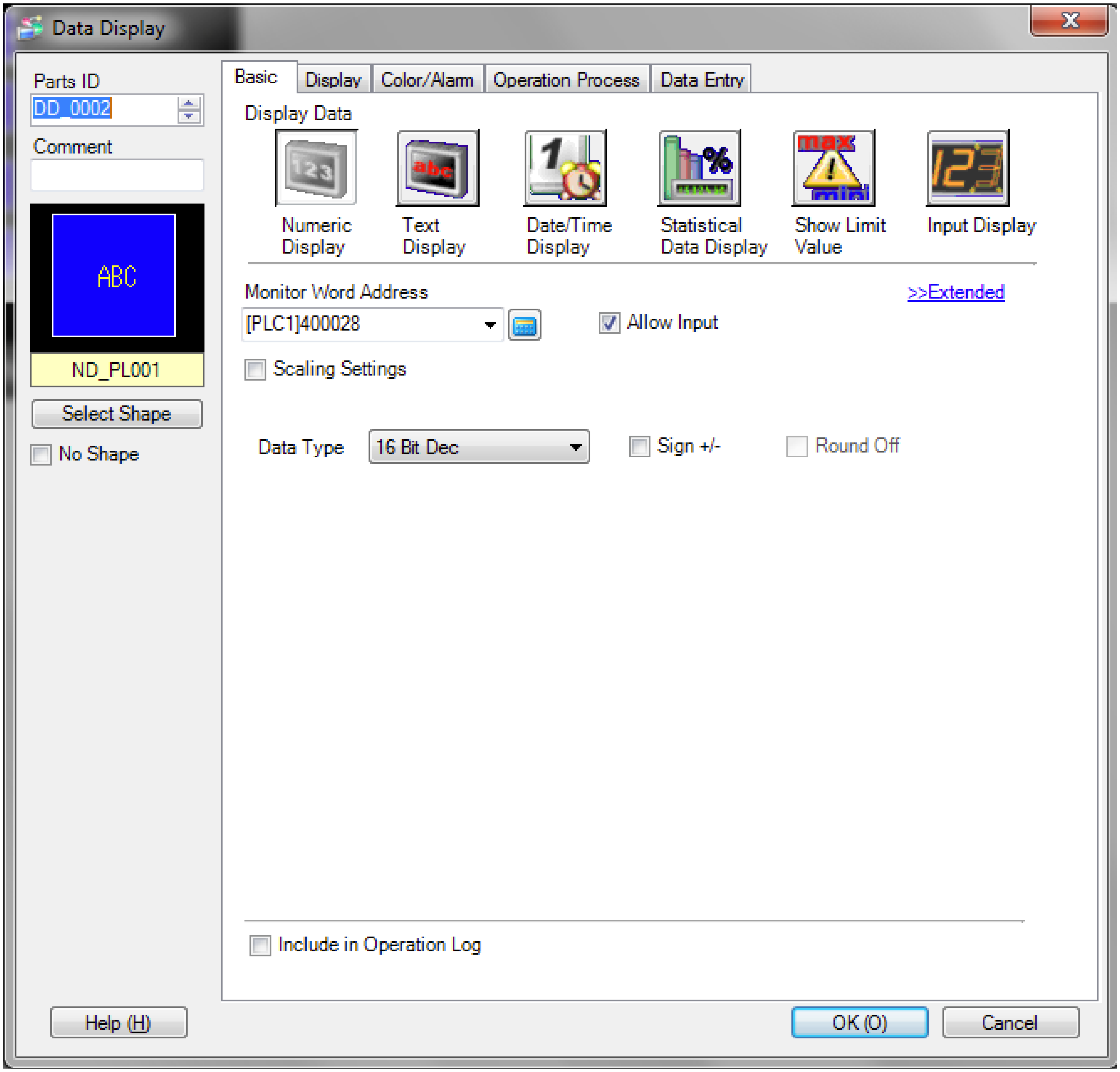
Register Mapping

The Modbus protocol is all about moving data from the memory of one device to that of another. You can move as little as one bit or you can move one or more 16 bit words. We'll be moving words, usually one at a time. These are the STM24 Modbus registers that we'll be using in this exercise:

Modbus Register Number	Use
40125	command register
40126	command info 1 field (used, among other things, for specifying which Q segment to launch)
40028..40032	move parameters (AC, DE, VE and DI)
40043..40045	jog parameters (JA, JL and JS)
40001..40015	immediate registers for monitoring the drive (AL, SC, IT, IU, etc)

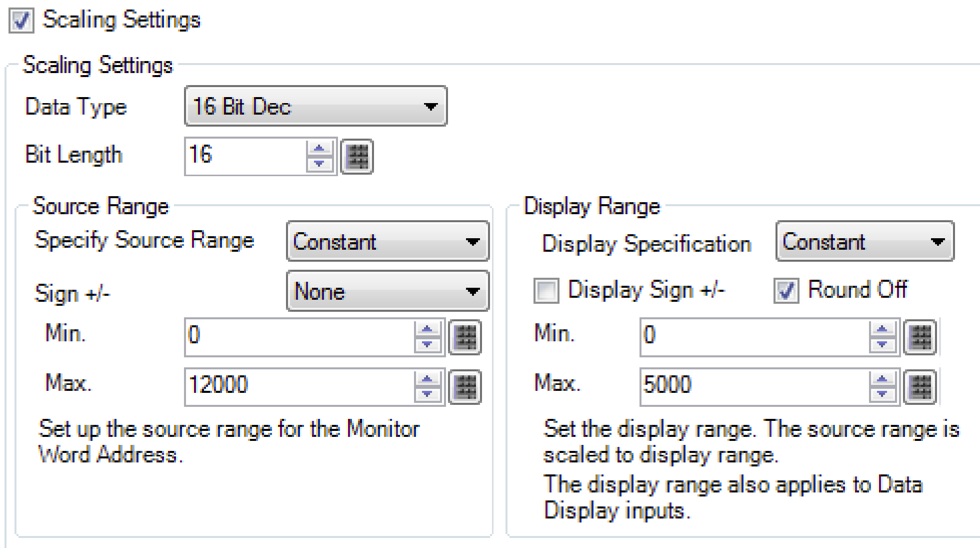
We'll need to map those to HMI objects that will display data from the registers and in some cases allow the operator to enter new data. This is straightforward, just add a data display object to an HMI screen and double click it to bring up the dialog. You set the Modbus register by clicking the blue button next to the

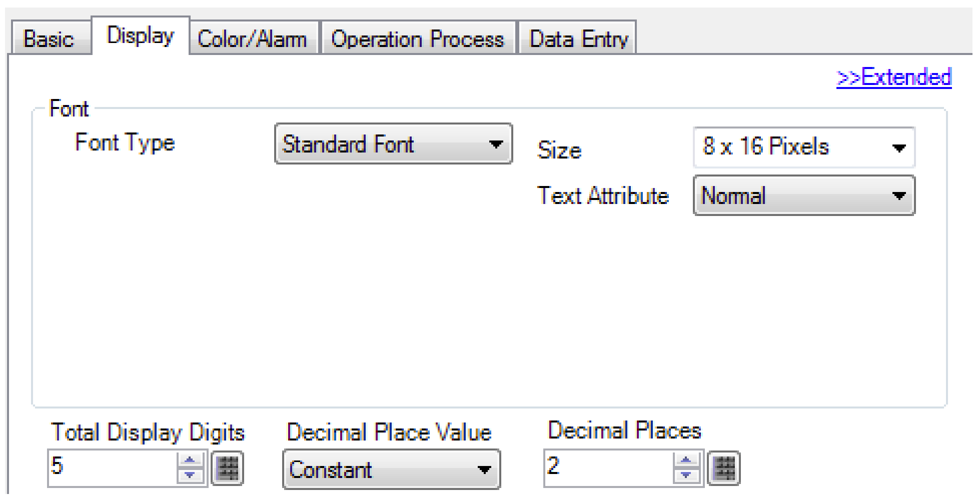
word address. ***In the GP Pro software, Modbus addresses show an extra zero; ignore it. You'll only be entering the last three digits anyway.***



For the most part, the mapping is simple, just create a data display object and click the "Allow Input" box if you want the user to be able to change the register's contents. If you want values displayed in more friendly units, you can select "Scaling Settings" and enter the range of values for the data register and the display. For example, the STM24 stores speed values as 0.25 RPM. Example: say we want to work in revs/sec with a range of 0 to 50 rev/sec, and two decimal places. Set the display range to 0 min, 5000 max. With the two decimal places, 5000 will appear on the HMI as 50.00 rev/sec. don't forget to click the Display tab and set the number of decimal places and total digits to be displayed on screen.

To complete the scaling, we'll enter the equivalent range of raw data from the register. Since the STM24 works in units of .25 RPM (1/240 rev/sec), we'll enter a source range minimum of 0 and a maximum of 240x50 = 12000.

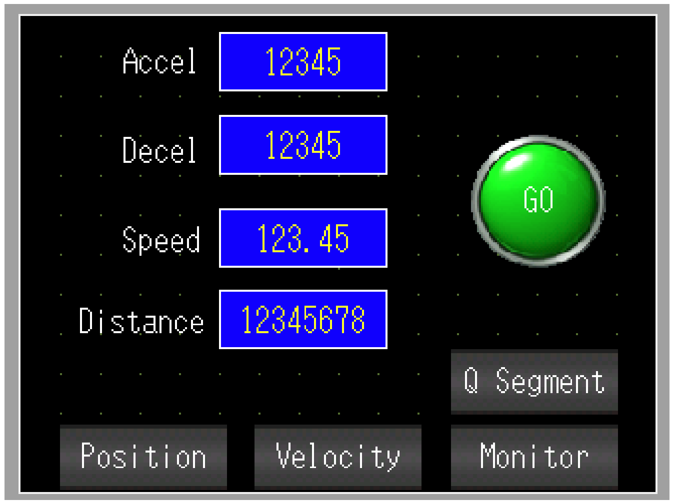


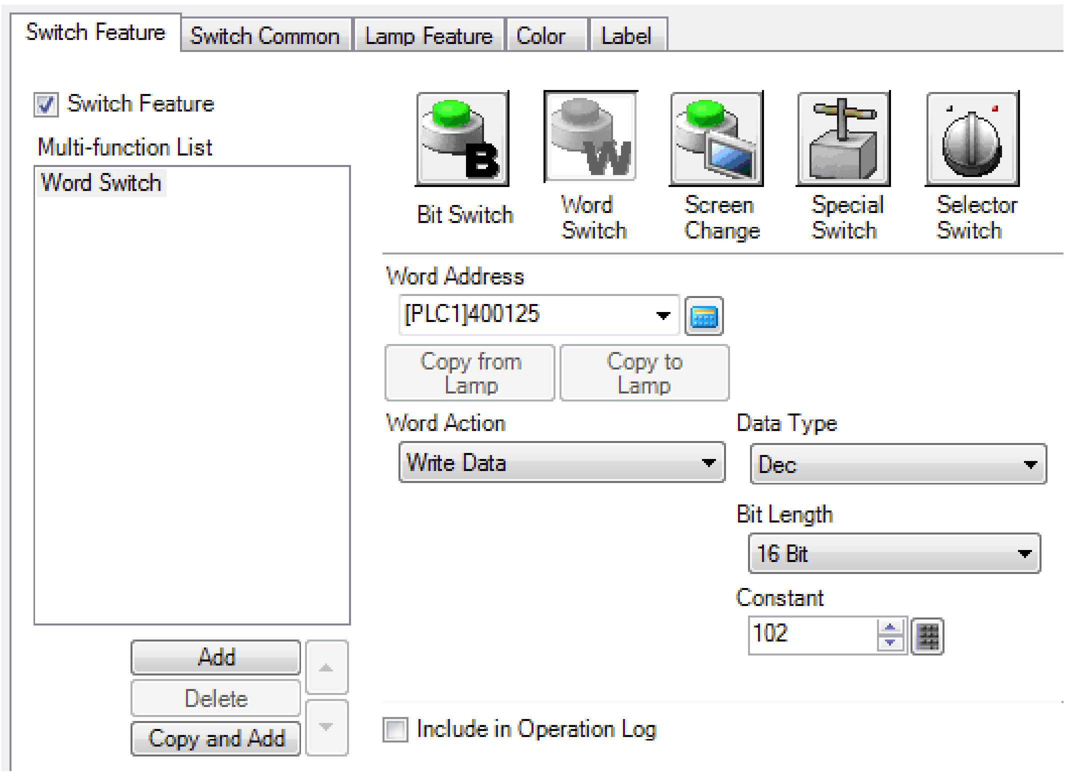


Once all the move parameters have been mapped to data display objects, it will be easy for the operator to adjust them. To execute a move, we'll need to send a specific value to the command register. We placed a pushbutton on the HMI for this, that maps to the command register (40125) and sends the fixed value 102 when pressed, which is the opcode for a point - to - point (FL) move.

During this exercise, we'll be writing opcodes to the command register to initiate various actions. This is a mere sampling of the many opcodes supported by Applied Motion Products drives. Please refer to our Modbus literature for more information.

Function	SCL equivalent	Opcode	Description
Feed to Length	FL	102	Starts a point to point move
Commence Jogging	CJ	150	Starts jogging
Stop Jogging	SJ	216	Stops jogging
Q Load & Execute	QX	120	Launches a Q segment
Stop & Kill	SK	225	Stops the Q program and halts motion





Big Endian, Little Endian

Modbus transfers 16 bit words. That's great for parameters like speed or acceleration because they are 16 bits. But move distance (DI) is 32 bits in our drives, as are some of the monitor values. Modbus is happy to move more than 16 bits of data at a time, but we need to pay attention to word order or we may be in for some unpleasant surprises.

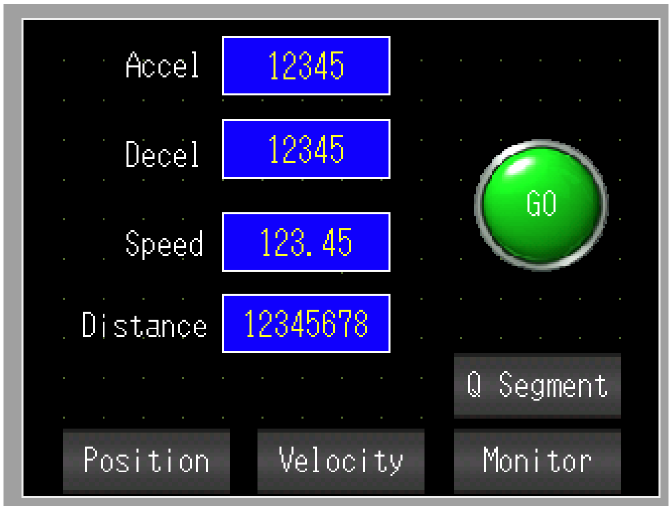
In our Modbus implementation, we default to storing the big end of 32 bit values in the first word of memory. That's called big endian. Consider, for example, setting DI for 100,000. That's 000186A0 hex, which is stored as two 16 bit words: 0001 and 86A0. The big end of the word (the most significant word, or MSW) is 0001 and it goes into the first register location, 40031. The little (least significant) end is 86A0 and that goes into the second word, 40032.

Great, but what if the HMI has other ideas? In fact, the GP4201 uses little endian word order for 32 bit values, so if I write 100,000 to a memory location, it will write the little end (LSW) first and the drive will see it as 86A00001. Not good. 86A00001 hex equals 2,258,632,705 decimal. That's a very long move.

To keep things simple for the PLC or HMI programmer, our drives have a switch that allows them to use little endian word order. Just select “little endian” when configuring the drive with the ST Configurator software. If your PLC/HMI needs big endian, select “big endian”.

Point-to-point Move

Building on what we’ve already accomplished, let’s program the HMI to initiate a point to point (fixed distance) move. We’ve constructed a screen with four numerical entry objects for entering move distance, speed, acceleration and deceleration. We’ll also add a pushbutton to start the move when pressed.



The four numeric entry boxes are mapped to the following Modbus registers:

Function	Modbus register	Data type
accel	40028	16 bit unsigned
decel	40029	16 bit unsigned
speed	40030	16 bit unsigned
Distance	40031	32 bit unsigned

The GO button, when clicked, sends the opcode for a feed to length move (102) to the Modbus command register 40125, which starts the move.

Velocity Move (Jogging)

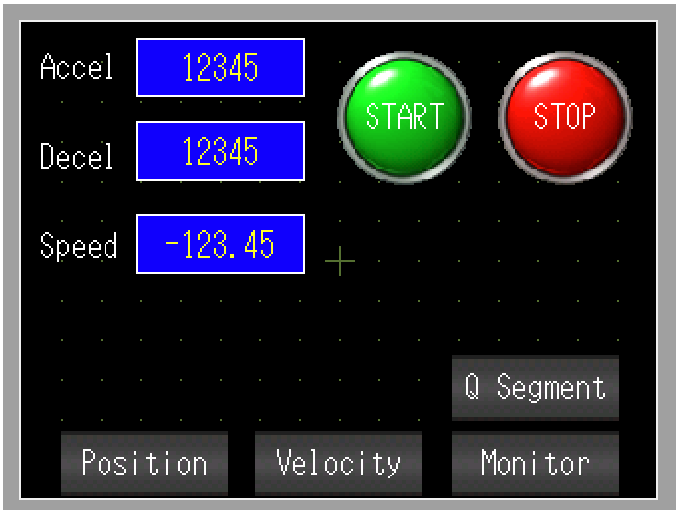
We’ve created another screen in the HMI for velocity mode. This time we have three numeric entry boxes that connect to Modbus registers in the drive:

Function	Modbus register	Data type
Jog accel	40047	16 bit unsigned
Jog decel	40048	16 bit unsigned
Jog speed	40049	16 bit signed

The velocity has been scaled into revs/second, assigned two decimal places and allowed a range of +/ - 50 rev/sec. That’s done by setting to source range to 12000 max and - 12000 min. The display range is 5000 max and - 5000 min. The scaling is a bit counterintuitive: our internal unit of speed is rev/sec*240. To achieve a range of +/ - 50 rev/sec, the source range must be set to +/ - 50*240 = +/ - 12000. If we were

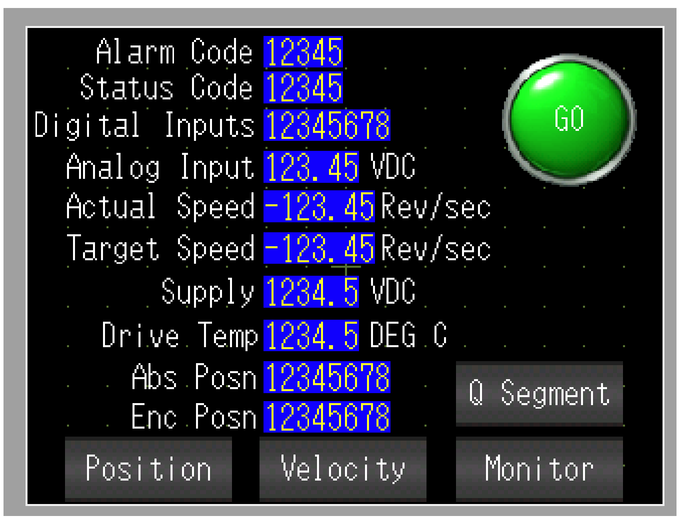
working in whole numbers (1 rev/sec, 2 rev/sec, etc) then we'd set the display range to +/ - 50. The get two decimal places, we must use a display range of +/ - 5000 which will show up as +/ - 50.00.

Also present are pushbuttons for starting and stopping the move. These send the proper opcode to the command register (40125) for starting and stopping a jog move: 150 for starting motion and 216 for stopping.



Monitor the Drive on the HMI

To monitor drive status, we've created an HMI screen with ten numeric display objects mapped to the STM24's Modbus registers so the user can observe drive status, motor speed, encoder position and much more. The monitor screen also includes a GO button so that the operator can observe the monitor data while a point-to-point move is taking place.



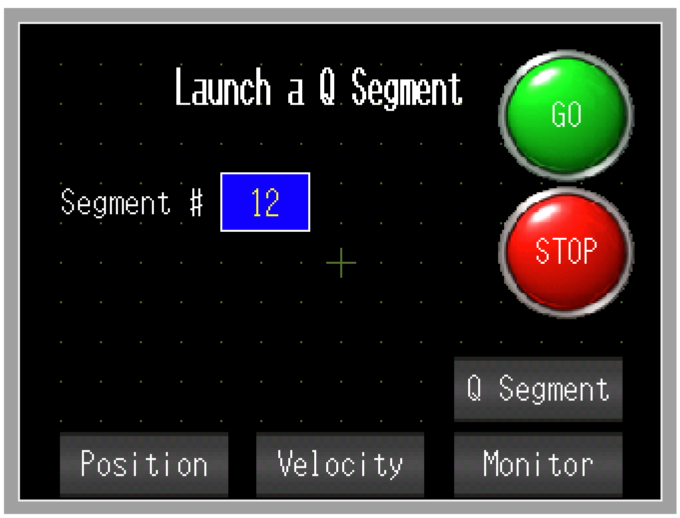
These are the ten Modbus registers connected to the monitor:

Function	Modbus register	Data type	Source Range	Display Range	Dec Places
Alarm code	40001	16 bit hex	-	-	0
Status code	40002	16 bit hex	-	-	0
Digital inputs	40004	8 bit binary	-	-	0
Analog Input	40017	16 bit decimal	0..16384	0..500	2
Actual Speed	40011	16 bit decimal	-12000..12000	-5000..5000	2
Target speed	40012	16 bit decimal	-12000..12000	-5000..5000	2
Supply	40014	16 bit decimal	-	-	1
Drive Temp	40013	16 bit decimal	-	-	1
Abs Position	40007	32 bit hex	-	-	0
Enc Position	40005	32 bit hex	-	-	0

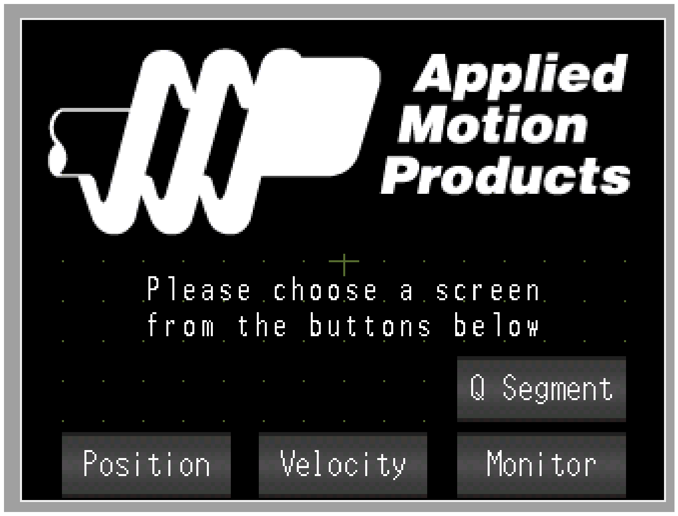
Launching a Q Segment

One of the strengths of the Applied Motion Products Modbus implementation is distributed intelligence. You can create and store up to 12 Q segments in the drive and launch them from the HMI. The Q segments can then operate the motor, interact with I/O, and make decisions on their own.

The segment number connects to Modbus register 40126. The segment is loaded and executed by clicking the GO button, which writes 120 to the Modbus command register (40125). To demonstrate the ability for the HMI to stop a Q segment, there is a STOP button that sends the opcode 225 to the command register. This halts the Q segment and stops any motion.



Finally, we added an intro screen with buttons to take us to the screen of our choice. This screen is shown at power up.



Complete project files for the Proface GP-PRO EX software are available at www.applied-motion.com.